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U.S.
DEPARTMENT
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National
Oceanic and
Atmospheric
Administration

National
Marine
Fisheries
Service

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator

National Marine Fisheries Service
Philip M. Roedel, Director

COVER: SHOVELING SCALLOPS ONTO CONVEYOR ABOARD 'SYLVIA MAE'. (R. D. Mauser)

. . .

Cover photo of July-Aug. 1971 issue--deck load of tuna caught off New England--was taken by J. J. Murray, NMFS Fishing Vessel Safety Officer, Boston, Mass.

COMMERCIAL FISHERIES

Review

A comprehensive view of United States and foreign fishing industries--including catch, processing, marketing, research, and legislation--prepared by the National Marine Fisheries Service.

FISHERMEN'S MEMORIAL--GLOUCESTER, MASS.

Editor: Edward Edelsberg

Production: Alma Greene

Throughout this book, the initials NMFS stand for the NATIONAL MARINE FISHERIES SERVICE, part of NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), U.S. Department of Commerce.

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Robert W. Schoning

John L. Baxter

SCHONING NAMED NMFS DEPUTY DIRECTOR

Oregon State Fisheries Director Robert W. Schoning has been named NMFS Deputy Director. He assumed his duties on Sept. 10.

Mr. Schoning will work with NMFS Director Philip M. Roedel on all aspects of fishery research and development on national and international levels.

He is well known as a fishery scientist and administrator. He was Oregon's fisheries director since 1960. Before that, he had served as Director of Research for the Oregon Fish Commission.

Extensive Background

Mr. Schoning, 48, holds a bachelor of science degree in fisheries from the University of Washington. He has done graduate work in fisheries and mathematics.

He is known for his writings on salmon and fishery subjects of the Pacific Northwest. He is a member of professional and conservation organizations.

The new NMFS Deputy Director is a member of the U.S. Department of State Fishing Industry Advisory Committee, chairman of the Pacific Salmon Inter-Agency Council, member of the Oregon Committee on Natural Resources, and advisor to the American Section of the International North Pacific Fisheries Commission.

BAXTER JOINS NMFS DIRECTOR'S STAFF

On Sept. 7, John L. Baxter, chief of the Marine Resources Branch, California Department of Fish and Game, assumed his duties as special assistant to NMFS Director Philip M. Roedel.

He will work in the areas of State-Federal relationships and recreational-commercial allocation problems. He will serve too as Executive Secretary of the Marine Fisheries Advisory Committee.

Mr. Baxter, 46, holds a bachelor's degree in wildlife conservation from the University of California at Berkeley.

Director Roedel said: "Mr. Baxter brings a wide background of fisheries research and administrative work to his new assignment, having served for 20 years with the California Department of Fish and Game in positions of increasing responsibility."

He is a member of the American Institute of Fishery Research Biologists and the American Fisheries Society, and a research fellow of the Marine Life Research Program, University of California at San Diego. From 1966 to 1970, he was editor-in-chief of the California Department of Fish and Game Fish Bulletins. He has written many publications on California fishery matters.

U.S. FOOD SITUATION

Prices for food to be consumed at home in 1971 probably will average around 3% above 1970. In 1970, the increase was 5.1%. The price uptrend in away-from-home eating will continue--but at a slower pace than last year. The index of all food prices is expected to average around 3½% higher for 1971. This information is contained in 'National Food Situation', Aug. 1971, published by U.S. Department of Agriculture.

Grocery Store Prices

Food prices at grocery stores increased in second quarter of 1971 following a year of relative stability. In first quarter, food prices at grocery stores were up less than 1% from a year earlier. But in April-June they jumped more than 2% to a level 2½% percent above a year earlier. This was largely because of shorter supplies and higher prices for fresh vegetables, and the continued strength in prices of fish, fats, and oil products.

Consumer expenditures for food increased 2% in second quarter to an annual rate of $119.7 billion. Further increases are likely as population, prices, and per-capita consumption continue to rise. An expected, large gain of 8% in consumers' after-tax income for 1971 will help expand demand. Food spending for 1971 may total 5½-6% above $114 billion of 1970.

Per-capita food consumption likely will show another significant increase this year. Meat products, mainly pork, will provide nearly all the increase. The fish prospect is for slightly lower consumption.

Fishery Products

The U.S. market for fishery products remained strong during first-half 1971. Sales of some major species fell slightly, but this was attributable primarily to shorter supplies. Conditions indicate a seller's market in most sectors. Prices have advanced sharply in the face of tighter supplies of shellfish and finfish.

Supplies of most shellfish are running below a year ago. Imports and domestic landings are down. Declines in shrimp imports particularly affect the market. To meet market requirements, despite drop in imports and domestic production, suppliers have trimmed sharply the inventories of frozen shellfish since the first of the year. The availability of stored supplies has made possible the same level for shellfish consumption as a year ago.

Similarly, supply shortages have affected the groundfish industry this year (mainly cod, haddock, and flounder). Imports, which account for over four-fifths of these products, are off from a year ago. Unlike shellfish, however, the groundfish industry did not have relatively large inventories to start this year. Thus, prices have advanced significantly. Groundfish sales are down from a year ago.

Halibut sales in first-half 1971 were consistent with last year. There were few price changes. Halibut production likely will be lower this year. Pressure on prices may build because of reduced supplies. Frozen salmon sales have improved over a year ago, and prices have been firm. Inventories have dropped sharply since the first of this year, but they are still above normal.

Canned salmon movements have been on a par with last year, but the 1971 pack likely will be below a year ago. So prices will move up. Canned tuna movement has picked up considerably since early 1971. Prices are expected to average higher than a year ago.

On balance, a slight decline in per-capita fish consumption is expected in 1971 after 3 consecutive years of increase. Shorter supplies and higher prices are mainly responsible.

FOOD FISH SITUATION

Total supplies of canned salmon during the first 6 months of 1971 were 2.7 million standard cases, 18% higher than the same period in 1970. The higher level was caused primarily by higher inventories at the start of 1971 carried over from the 1970 pack.

Anticipations of a smaller 1971 pack caused stocks to move at a slower percentage rate than in 1970. Inventories of red salmon have been large, while pink-salmon inventories have been a good deal less than in 1970. This was the reverse of the situation in first-half 1970.

Wholesale prices of red, chum, silver, and king salmon remained firm during January-June; prices of pinks, with shorter stocks, rose somewhat. Consumption has been slightly higher than last year despite firm and rising prices.

By Sept. 10, the pack of salmon was about a third below 1970. Reds ran extremely late; pinks in Southeastern Alaska did not appear in substantial quantity until early August.

In second-half 1971, supplies of salmon most likely will be considerably shorter than in 1970. Expected increases in prices for red and pink salmon were delayed because of the price freeze. Because of the smaller pack, a larger percentage of $\frac{1}{2}$- and $\frac{1}{4}$-pound cans will probably be marketed.

SARDINES

Supplies of sardines have been only slightly below 1970 levels. Low inventories carried into 1971 were almost offset by slightly higher imports and a higher domestic pack in first-half 1971. Sources of sardine imports changed--marked by sharp increases from Japan and continued declines from the Republic of South Africa.

Increases in herring landings for human consumption in most exporting countries indicate that U.S. sardine imports will be higher in the next 6 months. If the pack in second-half 1971 is close to last year's, consumption during July-December 1971 may about equal 1970's.

TUNA

Landings of tuna for first-half 1971 were slightly higher than for 1970 period. A considerably larger percentage of skipjack was caught.

Through May, imports of fresh and frozen tuna, particularly skipjack, were up sharply over last year; imports of canned tuna were down slightly.

For first-half 1971, total production of canned tuna was 6% higher than 1970. Tuna prices at all levels of distribution were much higher.

Landings of skipjack probably will continue to increase and to help overcome shortages of yellowfin. The pack likely will be a little larger in 1971 because greater supplies of skipjack will help maintain production.

--Morris R. Bosin
Clemens B. Bribitzer
Paul R. Beauchemin
NMFS Current Economic
Analysis Division

SHELLFISH SITUATION

The trends of the first 3 to 4 months of 1971 generally continued as supplies of shellfish, except northern lobsters, were lower than January-July 1970. Lower imports again were a major factor in the overall decline. Only imports of northern lobsters gained--boosting total quantity available above 1970.

Calico scallops rose fractionally; other species recorded lower landings than in 1970.

Declines in inventories of frozen shellfish have been extremely sharp this year. As in first months, heavy inventory withdrawals continued because lower imports and landings were unable to meet market needs.

During first 7 months of 1971, consumption of shellfish was generally lower than in 1970. The declines were not so sharp as the decreases in imports and landings would indicate. Despite record prices, consumption has remained high. Sufficient supplies were removed from inventories so sales declines were only moderate.

As a result of the continuing shortage of supplies and high demand, prices of domestic and imported shellfish have remained above those paid in 1970 for all but a few categories.

The outlook for shellfish during August-October was somewhat clouded by the possibility of a dock strike on the East and Gulf coasts on October 1 and the President's new economic policies.

--Richard S. Surdi
Donald R. Whitaker
NMFS Current Economic
Analysis Division

FDA ASSURES FISH EATERS

The Food and Drug Administration has given new assurance that deep-water food fish are safe to eat, Dr. Robert M. White, NOAA Administrator, said Sept. 21.

Dr. White released a statement by Dr. Charles C. Edwards, FDA Commissioner:

"With the exception of swordfish, the FDA continues to find no hazard to the consuming public from mercury contamination in deep-water food fish. . . . To assure that fish containing excessive mercury residues are not entering the market, a nationwide testing program, including inspection and spot analysis, is being maintained by the industry and the Food and Drug Administration."

Market Maintains Strength

Dr. White also revealed that NMFS statistics show that the overall U.S. market for fishery products maintained its strength during the early months of 1971. There was a "seller's market" in most sectors.

Prior to the wage-price freeze, he said, prices generally were advancing sharply. Supplies were short in many instances. Despite the supply condition, NMFS projects 1971 U.S. per-capita fish consumption only two-tenths of a pound less than last year's 11.4.

"This indicates to me," Dr. White said, "that the American people have exercised good common sense in continuing to enjoy a delicious food which is nutritious and wholesome."

STUDY TUNA'S TEMPERATURE PREFERENCE AND SENSING

A 3-year study will seek to learn where tunas are to be found in the ocean and why they prefer to be there. This was announced on Sept. 7 by Dr. Frank J. Hester, director of Hawaii laboratory, NMFS Central Pacific Fisheries Research Center.

Principal investigators are Dr. John J. Magnuson, University of Wisconsin, and Drs. Andrew E. Dixon and William H. Neill, NMFS.

The 3-year study will be funded jointly by NMFS and the University of Wisconsin.

Water temperature is an important factor in the distribution and behavior of tunas. But no one knows how important it is, or how tunas detect temperature, and the degree of their sensitivity to it.

2 Approaches to Problem

There will be two approaches to the problem: One will study fish behavior in temperature gradients. A circular tank will be constructed at the NMFS Kewalo Basin. In the center of the tank will be a concentric cylinder to create a donut-shaped swimming space equipped with heat exchangers and precise thermostats.

Temperatures within the donut will be uniform, but the experiment will be so constructed that the swimming rate will regulate the temperature rate change with respect to time. The fish will swim through a gradient of temperature in time--the faster he swims, the faster the temperature is changed. Direction of swimming will control the direction of temperature change.

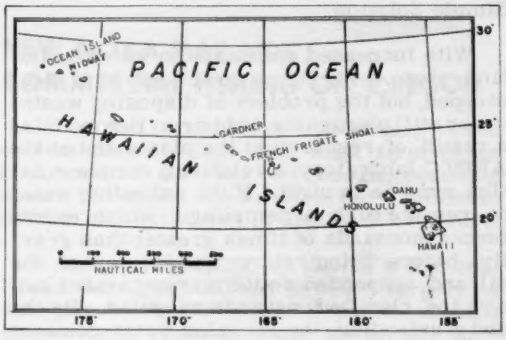
Electrophysiological Approach

The second approach to the perception of thermal gradients by fish will be electrophysiological. There will be space, holding tanks, and services for electrophysiological work. The temperature receptors of the tunas will be sought and studied.

Many believe that a fish senses temperatures on his body surface, his skin; the investigators, however, have postulated that a likely location of temperature sensors in fish is the olfactory rosettes--in his nose.

"Fish sniff," explained Dr. Magnuson. "A Pacific bonito previously tested was found to take a noseful of water every 75 seconds, or every 55 meters swum," he said.

The scientists hope to locate the primary thermal receptors and learn the ways in which these receptors contribute to temperature-oriented behavior. If the olfactory apparatus is sensitive to temperature, the fish, by sniffing, has the advantage of intermittent sampling. This would be a more effective way of sampling the gradual thermal gradients in the sea, Dr. Magnuson explained.



Results Will Be Useful

The study results will be compared with known water temperatures and oceanic distribution of fishes reported in the literature. They should be of special interest in Hawaii because they may improve the predictability of good and bad fishing years for the local fishery. Knowing more about the movements of yellowfin and skipjack tunas can be very important in Hawaii and throughout the entire Pacific.

NMFS HELPS INDUSTRY REDUCE WATER POLLUTION

A serious problem of the menhaden fishmeal industry is disposing of the water used during the unloading of fish from a vessel. The NMFS Atlantic Fishery Products Technology Center (AFPTC) in Gloucester, Massachusetts, is working with the industry to solve it.

In the unloading process, water is pumped into the vessel's hold. Then the mixture of fish and water is pumped out by large, specially designed vacuum pumps. The water is separated from the fish and pumped back to the vessel to continue unloading. As the water is recycled, it becomes contaminated with fish slime, blood, and fish oil. In the past, disposal of the unloading water was a simple matter--either it was dumped directly into the harbor, or it was put aboard a barge and dumped a short distance offshore.

Simple Solution

With increased emphasis on water-pollution abatement, these practices have been stopped, but the problem of disposing wastewater still plagues the industry. However, as a result of research at the plants and at the AFPTC laboratory, a relatively simple solution may be in sight. If the unloading water is run through a centrifuge, which exerts forces thousands of times greater than gravity, before being returned to the vessel, the oil and suspended solids are separated out, and the clarified water is recycled. By the end of unloading, the recycled water contains sufficient dissolved solids (primarily protein) to make it economically feasible to recover them. Also, the solids and the oil separated by centrifuging are introduced into the normal process stream, thus increasing the yield of fishmeal and oil.

EXCELLENT CHANCES FOR MAJOR FLORIDA SPORTFISHERY TO DEVELOP

There are excellent chances for the development of major offshore sportfishery off Florida's west coast, reports NMFS Tropical Atlantic Biological Laboratory (TABL), Miami. The prediction follows "Operation Loop," a 3-day exploration conducted in June by the Florida State University System Institute of Oceanography with NMFS support.

Excellent Fishing

Twelve sport fishing vessels and the NMFS 'Oregon II' steamed from St. Petersburg-Tampa area about 100 miles offshore to edge of Loop Current. Fishing was excellent there. Numerous gamefish were landed. One 200-pound blue marlin was boated; another large marlin was hooked but lost.

ARTIFICIAL REEFS ATTRACT FISH

Artificial fishing reefs are being built increasingly in marine waters to attract and concentrate fish. Nearly all below-surface structures--wrecked ships, aircraft, bridges, docks, and other materials--supply cover or a footing for the growth of crustacea, mollusks, and seaweeds, and produce a good sportfishing reef.

Artificial reefs have been built off San Francisco and Malibu Beach, Calif., Hawaii, Japan, and elsewhere. These reefs were made from auto bodies, pilings, concrete rubble and pipes, beer cases, streetcars, and old refrigerators. In selecting materials, the builders choose materials that are resistant to rapid corrosion, cost little, are available, and are cheap to handle, transport, and anchor.

NMFS Reefs

In 1966, the NMFS Marine Game Fish Research Laboratory at Sandy Hook, N.J., began to build and study artificial reefs. Old auto tires were readily available and suitable.

In 1969, the Sandy Hook Laboratory began to favor scrap auto tires as reef-building materials. Marine scientists developed two tire

units that can be carried offshore in any-size boat. These units enable the individual sportsman to share in reef building.

Tire Units

One unit is a single tire with a 15-pound concrete ballast weight wedged between the sidewalls. The second is a 4-foot-high stack of 7 or 8 tires held together with two $4\frac{1}{2}$-foot lengths of $\frac{3}{8}$-inch reinforcing rod (projecting through aligned holes drilled in each tire). These are anchored firmly in concrete ballast that completely fills the space between sidewalls of the base tire.

Auto tires have several advantages: readily available, do not decompose, corrode, rust, give off toxic substances and so are not pollutants. If the tires are placed properly, they will not be moved around or scattered by storms.

Unlike old car bodies, previously used to build artificial reefs, rapid corrosion is not a problem with concrete ballasted auto tires.

Usually, financing is a problem because it is difficult to promote private subscriptions. The problem of marking or buoying the reefs can be troublesome--but, without a buoy marking, it is difficult or impossible for fishermen to find the reefs.

VIMS Involved

Scientists and engineers of the Virginia Institute of Marine Science have been advising on projects to establish effective artificial fishing reefs. VIMS believes properly constructed and placed artificial reefs enhance sport fishing. It points out that the State's Marine Resources Commission must approve use of state bottoms for such structures. Similar clearance must be obtained from the Corps of Engineers, the U.S. Coast Guard and, sometimes, the U.S. Navy because metallic reefs can hinder submarine detection.

SHELLFISH SANITATION WORKSHOP IN OCTOBER

The Seventh National Shellfish Sanitation Workshop sponsored by Food and Drug Administration will be held in the Department of Health, Education, and Welfare North Building, 330 Independence Avenue, S.W., Washington, D. C., October 20, 21, and 22, 1971. Representatives of Federal and State Shellfish Agencies, the shellfish industry, foreign governments, and the academic community will participate.

For more information contact:

Division of Shellfish Sanitation (BF-230)
Food and Drug Administration
200 'C' Street, S.W.
Washington, D.C. 20204

NEW NOAA MAP AIDS COMMERCIAL FISHING OFF OREGON

NOAA has issued a sea-bottom map to aid commercial fishing. The map, first of its kind, covers an area off Oregon reaching about 120 miles north from the California border and out to sea to depths of 1500 feet.

It was prepared by NOAA's National Ocean Survey (NOS) and is based largely on data gathered by Commerce Department ships since 1889. Oregon State University furnished additional data.

What Map Shows

The map shows through different patterns the various sediments of the sea bottom--including mud, sand, rock, and muddy sand. Dr. Hyman Orlin of NOS said: "The map was prepared as a service to the fishing industry. Not only do some species of fish tend to congregate at certain depths, but they also prefer particular bottom cover. A knowledge of the characteristics of a region will reduce the fisherman's reliance on chance and increase his catch."

The map also portrays the topography of the sea bottom. It contains Loran lines that

enable fishermen to determine their position at sea. Previously, Orlin explained, fishermen had to consult two publications--a bathymetric map and a nautical chart--to determine the sea bottom's topography and their position. "Now we've furnished one map which will suffice for both purposes, with a portrayal of bottom sediment included as an additional assist."

INDEX OF WORLD PORTS IS UPDATED

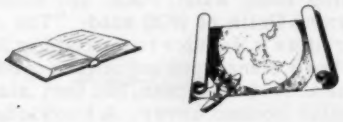
The U.S. Naval Oceanographic Office has published, in cooperation with the Navy's Military Sealift Command (MSC), an updated version of the "World Port Index." This contains useful information on 7,000 world ports.

The Index will help navigators and operations officers aboard ships and shore-based managers planning operations.

It includes data on tides, pilotage, loading and discharging facilities, maximum draft accommodations, port depths, chart number references, and available port services.

Available Soon

The loose-leaf index (Pub. 150) soon will be available to the public for $3 (without binder) from NAVOCEANO's Chart Sales Desk, Suitland, Md. 20390, and from its authorized sales agents in principal seaports around the world. It also can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402.



COAST GUARD EXTENDS SHORT-RANGE COASTAL RADIO MONITORING

The Coast Guard is extending its short-range coastal radio monitoring facilities. The program will provide "better distress, safety, and command and control VHF-FM (Very High Frequency-Frequency Modulation) communications coverage" for boats in coastal and major inland waters. The waters are those in which the Coast Guard has primary Search and Rescue (SAR) responsibilities.

The Coast Guard will add to existing facilities 100 new transceiving sites that will be organized into nets or zones with centralized control points. These unmanned sites, now 25 to 50 miles apart, will be channeled into a central net control through leased telephone lines and radio links. This will minimize number of trained operators needed to maintain watches throughout the system; it will relieve small stations of radio watch responsibilities.

The New Network

The new network will provide coastal coverage of the VHF-FM distress frequency (channel 16) to at least 20 miles offshore for the entire coastline of the continental United States. Large bodies of inland waters, such as Chesapeake Bay, Puget Sound, Long Island Sound, and the U.S. waters of the Great Lakes also will be completely covered. Over 50 sites are scheduled for completion by early 1972; the entire system should be working by 1975.

Also, the Coast Guard plans to equip its rescue aircraft with marine band VHF-FM radios and direction finders. Wide-area coverage will then be available to help locate distressed craft.

A pamphlet entitled "Marine Communications Pamphlet for the Boating Public" will be available in November 1971 from Coast Guard District Offices in Boston, New York, Cleveland, Portsmouth, Miami, New Orleans, St. Louis, Long Beach, San Francisco, Seattle, Honolulu, and Juneau (Alaska).

OBSERVATIONS ON REMOTE SENSING IN FISHERIES

William H. Stevenson and Edward J. Pastula Jr.

The application of aircraft or satellite remote-sensing systems to the problems confronting the fishing nations of the world is undergoing intensive development. Strangely enough, the evolution of sensing systems to acquire information about the ocean surfaces has outrun our understanding of the basic processes involved in fisheries identification, utilization, or management. This is due to rapid expansion of remote-sensing technical capabilities of several countries over the past ten years.

In looking for ways to utilize this advanced technology to benefit mankind, some very broad assumptions have been made, particularly in the application of remote-sensing technology to fisheries. These assumptions include: (a) direct application of satellite-acquired data to fishing operations; (b) direct use of oceanographic information by fishermen in their daily activities; and (c) the cause-effect relationships between the ocean environment and fish stocks are understood to the point of technical application. These assumptions were made by dedicated technical people who recognized a need to resolve the pressing world fishery problems. Unfortunately, few of these people are able to identify the cause-effect relationship of the fishery problems.

This developing technology of remote-sensing instrumentation from aircraft and satellites, as well as advanced communications and automatic data-handling techniques, are providing unique and exciting opportunities to obtain ocean information so rapidly that they were not comprehensible ten years ago. The challenge is to convert this mass of data to information which can be applied to fishery problems. This article identifies the areas requiring multidiscipline development of fisheries and the environment of fish.

Rational Resource Use Needed

Effective utilization of living marine resources depends on man's understanding of these resources under natural conditions. There is evidence that the world's capability to harvest living marine resources is approaching a point of diminishing returns. The effects of man as hunter and harvester of fishery resources and polluter of the resource environment are reaching a point where it is necessary for all nations to accept responsibility for rational resource management. Rational use depends on the location and identification of the fish stocks themselves--and of those ecological processes which the stocks rely upon for their food and survival.

As is true on land, the optimum use of the body of water by a living resource depends on the productivity of its environment. Over the years, expansion of knowledge about this environment has been significantly constrained by our inability to study the large-scale environmental phenomena taking place under dynamic conditions. Our present understanding of oceanic processes is based upon slow, scattered survey techniques, limited by man's ability to operate effectively on the ocean. This does not suggest that past efforts have not been significant. On the contrary, it suggests a phenomenal capability of extremely talented individuals to operate under adverse conditions and produce information of profound magnitude. A potential breakthrough in our ability to observe and record ocean-surface phenomena--and thereby revolutionize our understanding of living marine resources--can be identified in the numerous current resource-detecting efforts of several countries. Several efforts in the United States will illustrate the kind of research going on in at least nine other countries.

The authors are with National Marine Fisheries Service, Mississippi Test Facility, Bay Saint Louis, Mississippi.

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Fig. 1 - Application of Sensor Data to Fishery Utilization.

Who Can Apply Data?

Direct application of remote-sensing data to the problems of the fisherman in a dugout canoe is not practical (Figure 1). Data from remote-sensing system must be converted into oceanographic information which, in turn, must be integrated with extensive biological data to understand the status of the living marine resource with respect to its environment. Continued use of this resource will, in turn, depend on man's ability to effectively understand and manage the resource stocks within their natural environment. In the United States, the lead agency for developing this expertise and for integrating remote-sensing data with fishery applications, is the National Oceanic and Atmospheric Administration (NOAA) formed in October 1970. NOAA is concerned with resource exploration, development, management, and conservation in the oceans. It is also concerned with environmental monitoring, prediction, and modification, including living marine resources, and with developing the capacity to exercise, ultimately, some degree of environmental control. Here, environment means the oceans, the atmosphere, and solid earth. We are concerned with developing the science and technology required to execute these tasks.

CURRENT ACTIVITIES

SATELLITE AND AIRBORNE SENSORS

The present state-of-the-art of remotely sensing oceanographic and related factors from satellites and aircraft platforms has provided tools to view synoptically our natural resources on a scale not thought possible a short time ago. Within the last decade, a variety of sensor-mounted spacecraft and aircraft, both manned and unmanned, have provided oceanographic data on the following factors:

1. Water color (Gemini, Apollo, aircraft)
2. Sea state (aircraft)
3. Surface winds (aircraft)
4. Sea-surface temperature (Nimbus, ITOS, aircraft)
5. Chlorophyll (aircraft)
6. Surface currents (Nimbus, Gemini, Apollo, aircraft)
7. Sediment transport (Apollo, aircraft)
8. Surface salinity (mainly theoretical studies with limited experimentation from aircraft)

Sensor systems aboard the unmanned ERTS-A (Earth Resources Technology Satellite, and the manned Skylab/EREP (Earth Resources Experiment Package) satellites, to be flown in 1972 and 1973, will provide thermal and visual imagery applicable to oceanography. The mission of ERTS-A, to be followed by ERTS-B in 1972, is the repetitive acquisition of high resolution multispectral data of the earth's surface. The ERTS-A satellite will carry two sensor systems, one a four-channel multispectral scanner (MSS), and a three-camera Return Beam Vidicon (RBV). A five-channel MSS is programmed for ERTS-B. Technical details of the sensing systems, orbital plan, and operational characteristics are covered by literature available from NASA.

Even though ERTS-A and B, Skylab, and the ITOS series of satellites are not oceanographic-data oriented, the information acquired by their respective sensor systems will be applicable to initiating investigations of living marine resources. Future satellites, such as the unmanned ERTS-E and F, are expected to carry sensor packages and be programmed for specific oceanographic investigations as one of their primary functions. In this regard, the oceanographic and fishery communities have a responsibility to provide input requirements and to keep abreast of remote-sensing techniques and developments, whether the platforms be satellites or aircraft.

OCEANOGRAPHIC INFORMATION

To date, interpretation of satellite-generated visual and thermal imagery products are of a magnitude lending themselves to large-scale, gross oceanographic and meteorological phenomena which may be related to fisheries. The satellite-acquired data have been used to delineate upwelling areas, major current demarcations, sediment transport, and other large-scale surface features. Scrutinization of these features can be further explored with the aid of aircraft serving as

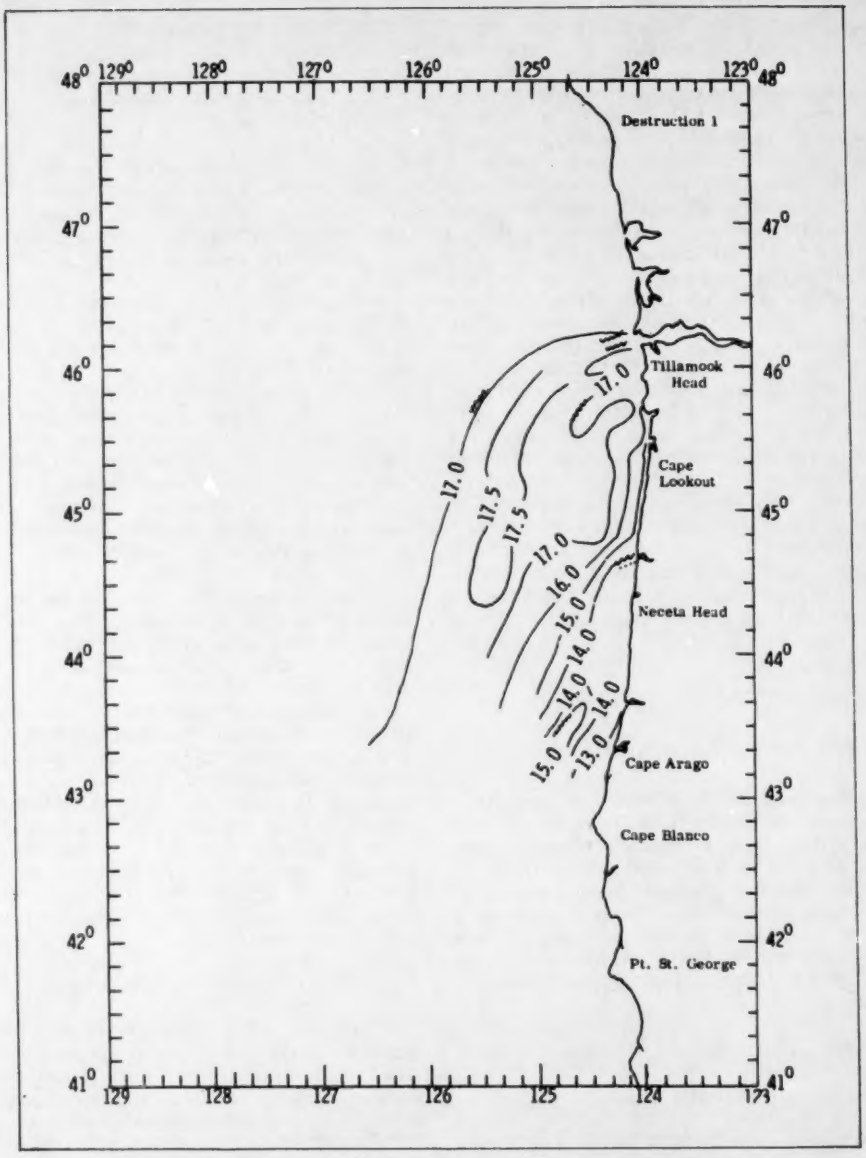

Fig. 2 - Sea-Surface Temperature off Oregon Coast (July 13, 1969) from Airborne PRT-5 Radiometer.

platforms for remote-sensing devices. The aircraft-acquired data, providing they are real time and convertible to fishery information, can become operational information for fishermen's use. Conceivably, these data may provide characteristics of, and relate to, the distribution and abundance of living marine resources.

This overly simplified sequence of events culminating in usable information may appear to be an ideal system for fishery development and utilization--but ideal systems are often plagued with problems when tested. Two primary problems must be resolved satisfactorily before any assessment, monitoring, and prediction program can become an efficient reality:

1. Agreement of the satellite and/or aircraft-acquired data with conventional oceanographic and biological sampling results, and

2. establishment of the relationship of environmental factors to living marine resources.

At present, the problems relating to data agreement are being investigated by a few fishery researchers. They are doing this primarily through conventional acquisition of ground-truth information, and by correlating these data with satellite/aircraft-acquired information obtained via remote-sensing devices. The process of correlating data from the two major modes of acquisition is costly and time consuming, but it is necessary to develop reliable and comparable airborne and satellite sensor systems. Those sensor systems applicable to fisheries are capable of scrutinizing only sea-surface phenomena with any degree of clarity, and subsurface features to an even lesser degree. However, we expect to be able to observe some resource information down to 100 meters in the next 5 to 10 years.

The second problem, relationships between living marine resource and the environmental factors affecting it, is even less understood. To provide the means for utilizing the resource effectively, we must also provide for an effective understanding of the complex relationship between living marine resource and its total environment.

Information applicable to the solution of these problems is being supplied by a few researchers investigating related oceanographic and biological phenomena. The factors and indicators of current interest are temperature, chlorophyll (color), sediment transport, and salinity. Other factors of importance, but receiving less concentrated attention, are surface and subsurface currents, oxygen concentration, sea state, and delineation of subsurface coastal features.

The measurement of sea-surface temperature has received most attention in sensing with satellite and airborne instrumentation. This study was given impetus by the results attained with meteorological sensing systems, primarily infrared radiometers designed for cloud studies. Thermal sensors were used and discussed by Pearcy and Mueller (1969) in a study suggesting a predictable relationship between temperature and albacore activities in Oregon waters. Figure 2, from their report, is an example of sea-surface temperature derived with the use of an airborne radiometer. A similar investigation conducted a year later, under similar conditions, did not support the original results, and Pearcy (1971) cited complex and rapidly changing sea-surface temperature patterns as a reason for the disparity. Additional research and mapping thermal variations of sea-surface temperature by remote-sensing devices are reported by Smith, et al. (1970).

Through the study of visible and infrared color photographic imagery taken aboard aircraft, Gemini, and Apollo flights, Clarke, et al. (1970) and Ewing (1971) explored the remote-sensing aspects of ocean color as an indicator of biological productivity. They analyzed the spectrum range of backscattered sunlight (Figure 3) from sea-surface areas rich and poor in chlorophyll. Kelly and Conrad (1969) used color aerial photography above clear, tropical water conditions in their study of shallow water benthos. In 1971, Kelly presented results showing the method could also be used in turbid, temperate waters to a depth of four meters. The work of R. E. Stevenson and Nelson (1968) resulted in an index of ocean features photographed from Gemini spacecraft. From spacecraft-generated photographs of the Gulf of Mexico, Lindner and Bailey (1969) correlated shrimp catch records with turbid water distribution. Mairs (1970) provided coastal oceanographic and sedimentologic interpretation of selected Apollo IX space photographs (Figure 4).

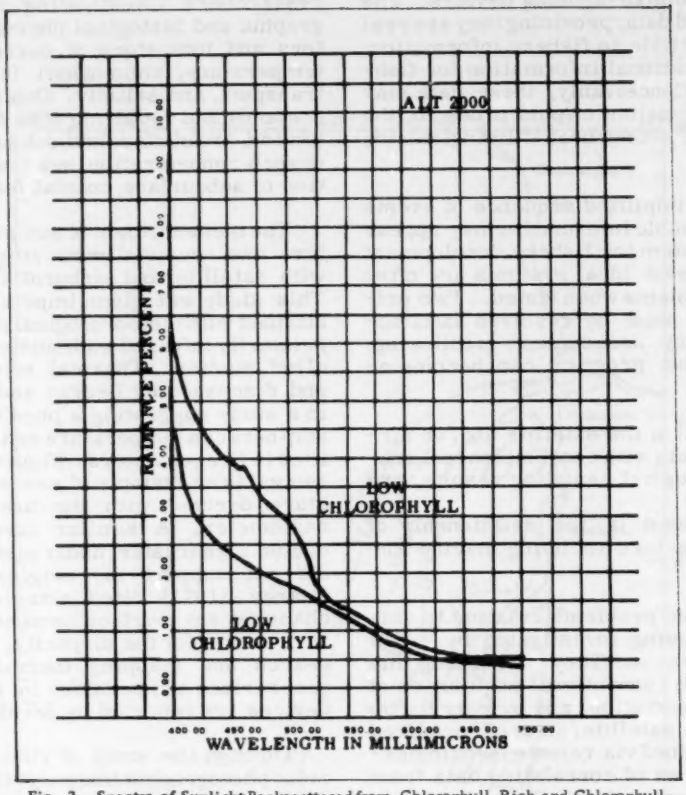

Fig. 3 - Spectra of Sunlight Backscattered from Chlorophyll-Rich and Chlorophyll-Poor Areas at 2000 Feet.

The measurement of sea-surface salinity by aircraft-mounted remote-sensing systems is in a theoretical stage. However, some experimentation has been done. Droppleman and Mannella (1970) used a passive microwave radiometric sensor system in their study of salinity variations of the Mississippi River plume.

The Earth Resources Laboratory (ERL), near New Orleans at the Mississippi Test Facility (MTF), is investigating sea-surface salinity measurements using remote-sensing techniques. Other remote-sensing systems and research applicable to fisheries has been done and is continuing by Roithmayr (1971) in his work with fish-school identification using low-light-level imagery. Investigations in fish-spectral signatures and the possible identification of fish-generated surface oil slicks may provide more fishery tools.

Potential applications of remote sensing to fisheries have been described by W. H. Stevenson and Johnson (1970), Drennan (1971, Figure 5), R. E. Stevenson (1970), Maughan (1969), and others.

FISHERIES

Expansion of world capability to harvest the known fish stocks has demonstrated man's capability to overexploit them. Some stocks, herring and menhaden in the Northwest Atlantic Ocean, for example, have been fished far below their capacity to produce large, sustained, harvestable surpluses. Current harvesting and management practices are based upon a very rudimentary knowledge of the marine ecosystem. To compound these problems, the use of the oceans as a dumping area for man's wastes can pollute the marine environment, and ultimately reduce its capacity

Fig. 4 - Oceanographic Interpretation of Apollo IX Photograph AS9-3128.

to sustain these resources. This is particularly dangerous for coastal waters, where increasing pollution and other environmental modifications occur, and where many important fish and shellfish resources are found.

The marine ecosystem is an extremely complex system. It consists of many organisms of diverse life forms interacting with one another and with the physical environment. The dynamic nature of this system is known mostly through conceptual models. This is due to the facts that significant biological events in the ocean take place over a large scale in time and space--and the difficulty and expense of making observations in the sea. The models are not adequate to account for the large natural fluctuations that occur frequently in animal populations. Perhaps this should not be surprising because the models are based on a patchwork of studies, generally unrelated in time and space, and usually very limited in scope.

In particular, there has been a tendency to divorce physical and biological oceanographic studies. Physical oceanographers have stressed investigations designed to determine the processes controlling the large-scale patterns of oceanic circulation; by comparison, they have used relatively little effort in many areas of high biological productivity, particularly the coastal regions. There, physical processes are very complex and significant changes in currents, temperature, etc., occur rapidly.

For their part, biologists have concentrated their studies over continental shelves and regions of upwelling, where nutrient levels and production of living resources are high; generally, they have worked without the benefit of adequate concurrent studies of the physical environment to help determine the interactions between the biotic and nonbiological factors. New approaches are required where both biological and physical environmental studies are pursued concurrently.

Integration of oceanographic and fishery resource information is now being attempted by several national agencies. The Natural

	SENSOR							
OBSERVABLES	MULTI-SPECTRAL CAMERA	METRIC CAMERA	LASER	SPECTRO PHOTOM-ETER	RADIATION THERMOM-ETER	THERMAL MAPPER	LOW LIGHT LEVEL TV	MICRO WAVE RADIO METER
SCHOOLS	●	●	●	●			●	
FISH COLOR	●			●				
WATER COLOR	●	●		●				
SURFACE ANOMALIES	●	●		●			●	●
UPWELLING	●	●		●	●	●		●
BIOLUMINESCENCE							●	
PLANKTON			●				●	
CURRENTS	●	●		●	●	●		●
SURFACE TEMPERATURE					●	●		●
SEA STATE		●	●					●
FISHING ACTIVITY	●	●		●			●	

Fig. 5 - Remote Sensors and their Potential Application to Fisheries.

Environment Research Council (NERC) of the United Kingdom, for example, is developing a comprehensive program to study the biological/environmental relationships in the North Atlantic and North Sea. In the United States, a similar national program called Marine Resources Monitoring, Assessment, and Prediction (MARMAP) is under development. MARMAP will monitor fluctuations in the distribution and abundance of various fishery resources and relate them to environmental factors and to exploitation by man. Also, it will provide the mechanism to establish a comprehensive description of other marine ecosystems in terms of the distribution, composition, and interrelationship of biological communities.

Oceanographic information obtained from remote-sensing data can play a critical role in these programs. One example is the identification of thermal fronts obtained from the NOAA/ITOS satellite system (Figure 6). Photographs, available for direct readout, identify the thermal boundaries in photographic form and can be digitized by computer. However, the usefulness of this information in fisheries other than to deploy ships is not well defined. The NFRC and MARMAP programs previously mentioned include surface experiments to improve the relationship of oceanographic data to fishery resources.

The application of remote sensing to fisheries can be classed in two general areas: ecology and utilization.

Ecological Applications

Application of remote sensing to our understanding of the ecology of the ocean depends primarily on development of bio-environmental models. A potential of greatly accelerating our level of knowledge exists in the ability to conduct synoptic surveys. This new survey technique itself will require a considerable amount of research and development--and concerted effort not to bend the results to fit classical procedures, but rather to use the two elements to advance the state-of-the-art. Concurrently, incomplete models of oceanic processes must be altered or completely restructured using the new knowledge from remote-sensing data. Examples of present work to develop these modifications are in the National Environmental Research Council programs of Great Britain, the National Oceanic and Atmospheric Administration programs in oceanography, the National Aeronautics and Space Administration's Earth Resources programs in the United States, and others.

In the fishery world, resource status models relating fish stocks to environments are just coming into their own. Models are being developed to relate major environmental indicators to the quantification and qualification of fishery stocks. These types of models are being developed by NOAA's National Marine Fisheries Service. The models, initially based on classical data, are designed to advance our understanding of the ecological relationship. For example, remotely sensed thermal data from ITOS satellites are being correlated with yellowfin tuna models developed by the Inter-American Tropical Tuna Commission. The purpose is to determine the practicability of using satellite-obtained sea-surface data as a major component in predictive resource availability models.

Validation of any model will require the acquisition of a considerable amount of ground-truth data currently available through classical survey techniques. By intensifying oceanographic and fishery survey activities for the next 5 years, we can expect to identify the factors necessary to establish the validity of remote-sensing data applications to the fisheries. The surveys planned in international efforts such as CICAR, UNDP special fund projects, and the FAO Indian Ocean Investigation are significant examples. National programs also will contribute to establishing the relationship of remote-sensing oceanographic information to resource status models: the MARMAP program, and a similar one in Great Britain, for example.

Utilization

Primary application of remote sensing to direct use of fishery resources most likely will come from the location and identification of harvestable stocks. Such information will be attained by direct sensing from aircraft and inferred information from oceanographic ecological data. Application of direct location and identification of fishery stocks is not well understood. Techniques for correlating information from ocean surface with patterns taking place beneath it are not now available. These techniques are projected to become available within the next 3 to 5 years. The most promising techniques being developed in the U.S. are low-light-level image intensification and laser instrumentation systems.

I-TOS 1 Orbit 3364 October 19, 1970
0900 GMT
10.5 - 12.5 m Black - Cold
32 grey scale steps 1 1/2 °K White - Warm
NOAA-NESS-ESG

Location of thermal fronts from Satellite Data. NOAA/ITOS Infrared image of east coast of US showing large thermal characteristics in coastal waters as well as distinct Gulf stream boundaries.

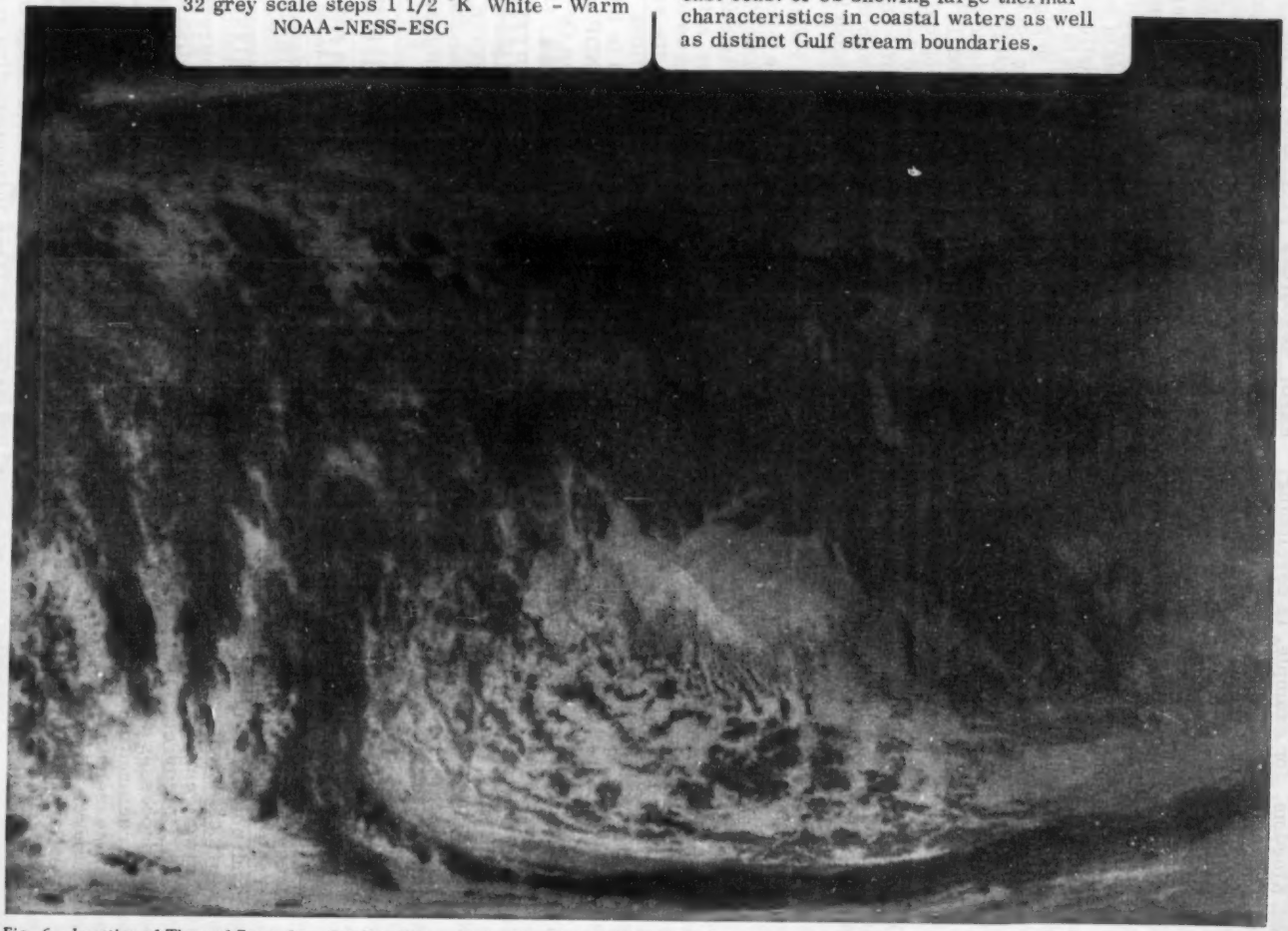

Fig. 6 - Location of Thermal Fronts from Satellite Data. NOAA/ITOS Infrared Image of U. S. East Coast Showing Thermal Characteristics in Coastal Waters and Distinct Gulf Stream Boundaries.

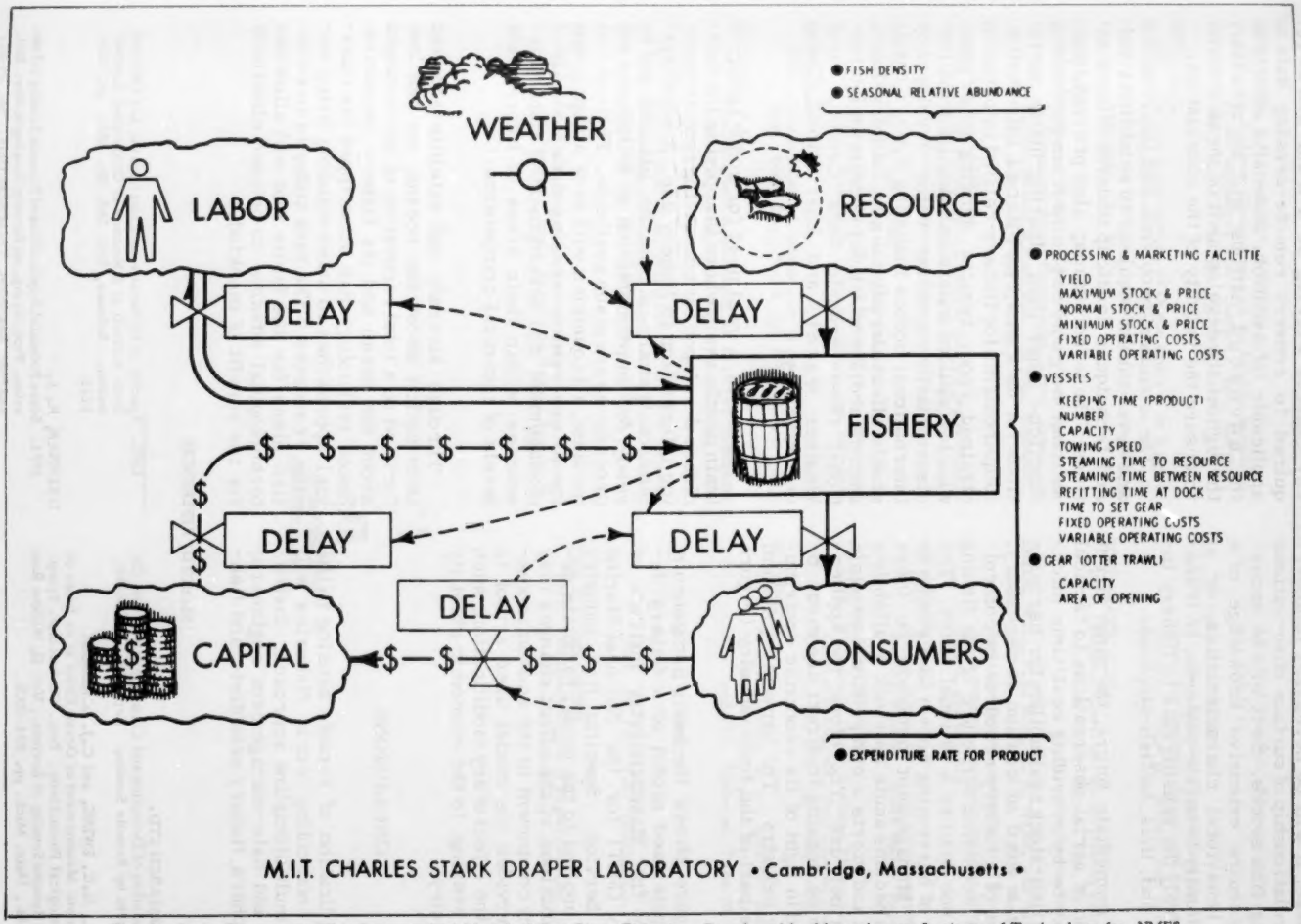

Fig. 7 - Basic Components of a Computerized Model of Any Given Fisheries--Developed by Massachusetts Institute of Technology for NMFS.

To use these, it will be necessary to understand the relationship of surface observations to existing fish stocks. So it will be necessary to acquire extensive knowledge of a species' behavioral characteristics, or at least the family behavior patterns, to transfer effectively the sensing data to fishery information and, thus, to fish-stock use.

In the immediate future, the most direct application of aerial observations to tactical fishing may be by providing real-time information on fish-stock availability for harvesting. Here a word of caution is necessary. Utilization of a fishery resource is controlled by the economic structure of the fishing industry, one man or a national effort. The capability of harvesting known fish stocks is available. Management demands on these resources become acute as stock availability decreases and exerts a competitive economic demand on their use. Therefore, the application of remote sensing to direct use must be considered in light of its economic contribution to the industry. The harvesting system is only one part of the total industry (Figure 7).

This figure shows the basic components of a computerized model of a fishery developed by the Massachusetts Institute of Technology (MIT) for the National Marine Fisheries Service. Specific fish industry inputs are applied to the model to obtain detailed predictions of the effect changes may make on any component in the economic system. It provides the model user a tool to determine the effect of any modification, such as remote sensing, to the economic stability of the industry.

CONCLUSIONS

The application of remote sensing to the problems confronting world fisheries will require a multidiscipline approach. Instrumentation and data-management engineers, oceanographers, fishery scientists, and fishery experts working as a team will be required to convert remote-sensing data to applicable information. Extensive efforts by the advanced nations will be necessary throughout the development of these systems to ensure the validity of the conclusions.

The complex problems and the research and development required to establish standard techniques handicap underdeveloped nations. These factors may also prevent international organizations from performing functions other than clearing-house operations for data and technical information. Requirements for fishery-related information obtained from remote sensing most likely will be fulfilled within existing information-dissemination systems being developed by international bodies including FAO. Considerable effort already has gone into developing such data-dissemination program as International Oceanographic Data Center, World Weather Watch, and International Global Ocean Survey.

There is a real need for some agency to train people everywhere in applying the techniques developed for converting remote-sensing information to fishery use. A basic system of training should be planned and be ready for implementation as techniques and procedures are made available. Through this medium, all countries will have an opportunity to use remote-sensing data for rational management and development of fishery resources within their areas of interest and levels of technical competence.

Through aircraft and satellite-acquired information about the oceans, we can look forward to a total renovation of our concepts about the ocean and its fishery resources. Space technology has outstripped the classical approaches to understanding living marine resources. The task today is to establish plans for the future that will allow this technological advance to be used effectively for the benefit of mankind.

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PROSPECTS FOR SEA FARMING IN PACIFIC NORTHWEST

Timothy Joyner and C. Gunnar Safsten

The sheltered bays, sounds, and estuaries of the world's coastal zones have much potential for increasing the production of quality seafood. By development of appropriate systems of "sea farming," or mariculture, such waters can be used for the production of seafood in the same way that the flood plains of river basins have been used for agricultural production.

The products of mariculture can be expected to stimulate expanding markets as their production, processing, and distribution become more efficient. Perhaps even more important: by providing an economically attractive incentive for clean water, the orderly growth of mariculture can help prevent further despoilment of coastal waters by uncontrolled urban and industrial growth.

PUGET SOUND--A POTENTIAL SITE FOR SEA FARMING

Puget Sound, in the State of Washington, is an inland sea with over 2,300 miles of shoreline, much of it protected from strong winds by high bluffs. Its deep waters are well flushed by strong tidal action and enriched in nutrients by abundant runoff. In the main channels, the temperature is remarkably uniform throughout the year (7°-13° C.), whereas in the shallow, less saline waters at the heads of inlets, it ranges from 4° to 18° C. Salmon, oysters, clams, and crabs were once plentiful and provided abundant food for early Indian populations. These resources have since declined under population pressure and indiscriminate land-use practices. The native oysters, for example, have been virtually wiped out.

To recover the capacity of the Sound for high, sustained yields of valuable sea products, it will be essential to prevent further deterioration of its waters and to restore their pristine quality. In planning water uses for the Sound, it must be recognized that mariculture can play a major role in restoring and expanding the yield of living resources from this unique inland sea.

MARICULTURE SYSTEMS

The basic properties of water areas that must be considered in mariculture planning are essentially the same as for other life-support systems: Space, temperature, and availability of oxygen and suitable food--not to mention the means for disposing of, or recycling, wastes. For any given system, requirements for these properties will vary according to the organisms to be cultivated, the "loading" capacity of the system, and the extent to which the system is open or closed. Consider the following examples:

Feed Lots

In this type of system, the cultured organisms are held in enclosures, such as cages or pens, in which they are given prepared feed while being grown to marketable size. Such a system requires a high flow of clean water to carry in fresh oxygen and to carry away unwanted wastes and bacteria. The temperature of the water should be sufficiently high to sustain an economically satisfactory rate of growth relative to amount of feed supplied, yet sufficiently low to discourage the proliferation of disease.

Grazing

These usually are systems in which space is not a major constraint and in which natural feed is a component of the water supply. Suspended culture systems for molluscs fit into this category, as do systems in which small fish and shrimp are held in tidal rearing ponds to feed on natural food. In such systems, the

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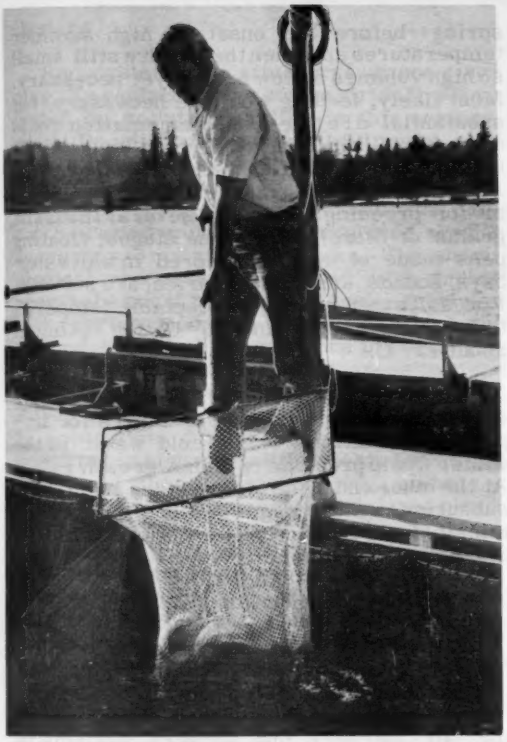

Fig. 1 - Many marine fishes normally range thousands of miles through the rich pastures of the sea. However, some of them can be grown in dense concentrations in large floating or submerged pens and diked ponds. Some species, such as the salmon in this pen, must be fed specially prepared foods to produce rapid growth.

Fig. 2 - Valuable shellfish can be cultivated in great densities in our estuaries, where they "graze" on the plankton-rich waters. In Spain, bay mussels are grown on ropes 6 times longer than the one shown here, and produce "crops" of over $\frac{1}{2}$ million pounds of whole mussels per-surface-acre in 1 year.

new water must carry, in addition to oxygen, either sufficient food organisms or nutrients. Flushing must be adequate to remove or dilute wastes to tolerable levels.

One variant of grazing is open-range culture in which spatial restraints are unnecessary. In mariculture, an open range is possible with anadromous species, such as salmon, which undertake predictable homing migrations. Young, hatchery-reared fingerlings, imprinted by the fresh water in which they have been reared, return to the rearing site after several years of growing and fattening in the sea. Fishery scientists are now armed with new insights into the effects of juvenile rearing conditions on the behavior and survival of adults at sea. They believe that it may be feasible--by carefully controlling rearing conditions for juvenile salmon--to increase significantly the number returning to homing sites and, to a limited extent, to influence the distribution of adults at sea.

For example, recent studies by the Washington State Department of Fisheries lead us to suspect that coho salmon from Puget Sound hatcheries, held and fed beyond their normal release date in April until July 1, do not migrate to the ocean as do their siblings released earlier. Instead, they stay in Puget Sound to grow to adulthood, thereby becoming more accessible to local sport and commercial fishermen.

Hatcheries

For hatchery production of eggs, larvae, and small organisms requiring neither large amounts of space nor large volumes of water,

methods have proved useful in which part of the water is recycled after treatment to remove wastes, inactivate deleterious microorganisms, and to replace oxygen. An advantage to be gained from recycling is the relative ease and economy of controlling the water temperature, thus allowing control over the rate of development of eggs and larvae. This makes it possible to stagger the planting of juveniles to extend the harvesting period.

PRODUCTS OF SEA FARMING

Salmon

Recent experiments have been conducted in Puget Sound by the National Marine Fisheries Service (NMFS). In salt water of the proper temperature and sufficient flow, and with appropriate feed, it was possible to rear coho salmon from fingerlings weighing 5 to 10 g to marketable fish weighing 300 g in 6 months with negligible losses. Conversion of feed was efficient--better than one unit weight of growth for each two of feed.

Fig. 3 - These coho salmon were "farm-grown" in the sea at a NMFS research station near Manchester, Wash. When placed in saltwater pens, they weighed $\frac{1}{20}$ of a pound. Fourteen months later, when "harvested," they weighed over a pound. More than 700 of these fish have been shipped to many sections of the United States to test consumer reactions.

Clear, fresh water is required for the incubation of salmon eggs and for the rearing of young until they start feeding. Ideally, the water temperature should be between 9° and 12° C. Partially recycled water can be effective at this stage. The fry can be reared to about 10 g most efficiently in slightly brackish water. Brackish lagoons might be used in the spring--before the onset of high summer temperatures and when the fish are still small so high volumes of flow are not yet necessary. Most likely, feeding would be necessary, but substantial dietary supplementation could come from natural food in such lagoons. In the final stages, the fish would be reared from 10-g fingerlings to a marketable size of 300 g, or for breeding (reared to several thousand grams or more). For these stages, floating pens made of netting, moored in saltwater bays, sounds, and tidal estuaries, are suitable. For saltwater rearing, acceptable temperature limits are 5° and 15° C, the optimum about 12° C.

Heat from the discharges of electric power stations could provide opportunities for improving conditions where cold water in the winter would preclude optimum growth rates. At the other end of the temperature scale, cool subsurface waters might be circulated economically to the surface where summer temperatures are too warm.

NMFS Experiment Station

At the NMFS Experiment Station at Manchester, Wash., ways are being developed to utilize the energy and food naturally available from the waters of Puget Sound. Fresh water for our hatchery and nursery systems is drawn from a creek and piped for about 800 m beneath a small bay to a delivery site at the end of a pier. Since the annual temperature range of the salt water at the bottom of the bay is considerably less than that of the creek, the piped creek water is cooled in the summer and warmed in the winter. To take advantage of tidal currents, saltwater rearing pens are placed where current velocities fall between 0.05 and 0.5 knot; this is sufficient to give a good exchange of water in the pens without exerting excessive lateral pressure on the nets, or stress on the mooring system. During periods of the growing season when there is an abundance of plankton suitable for food, underwater lamps are used to attract the plankton either directly into the pens or to the intake of a plankton pump.

On the basis of the salmon feed lot experiments, it appears that the western shore of the Sound's central part, including Admiralty Inlet, has the best potential for rearing salmon in salt water. High bluffs provide excellent protection from the southwesterly storms that prevail in winter. Moreover, there are relatively few large communities and industrial developments on the western side.

Oysters

For oysters, the situation is more complex. To replace native stocks virtually eliminated by pollution earlier in this century, most Puget Sound oystermen import seed from Japan and Korea. Although water conditions are generally favorable in Puget Sound, appropriate spawning conditions cannot be relied upon. So the imported seed is necessary to maintain the stocks. The physiological processes associated with growth seem to be out of phase with those associated with reproduction in these oysters, which are attuned to different conditions prevailing in Asian waters. In maturing Japanese oysters planted at the heads of inlets in southern Puget Sound, physiological stresses appear to accumulate during the second summer, resulting in high mortalities. Otherwise, the waters of these inlets are well suited for them. Recent studies show that delayed planting, better preparation of oyster beds to reduce turbidity close to the bottom, moving oysters before their second summer from beds at the heads of the inlets to cooler waters near the entrances, and suspended culture techniques to take advantage of deeper water should significantly reduce summer mortalities and promote production of higher quality oysters.

Current construction by the Lummi Indians of a shellfish hatchery on their tribally owned tidelands near Bellingham, Wash., is very encouraging. If successful, it should improve the prospects for mass production of the seed of mortality-resistant stocks. The basic techniques for producing oyster seed are applicable to other molluscs such as clams, scallops, abalone, and mussels. Commercial shellfish hatcheries have recently been established in Long Island Sound and in California. Their development in the Pacific Northwest should lead to better husbandry practices by the shellfish industry--with resultant improvements in the quality and diversity of its products.

Prawns

Prospects for the culture of the spot prawn, a delectable crustacean native to Puget Sound, have been enhanced by recent advances at the University of Washington. Artificial culture of this species to postlarval stages was successfully accomplished in a recirculating saltwater system. Further development of the technique, designed to extend the product to market size, is planned by University researchers with the cooperation of NMFS, which will provide running saltwater facilities at its Manchester Experiment Station. The spot prawn, a scavenger, could have much promise as a component of multiple-culture systems. Wastes from the rearing of fish and molluscs might be used effectively by the prawns.

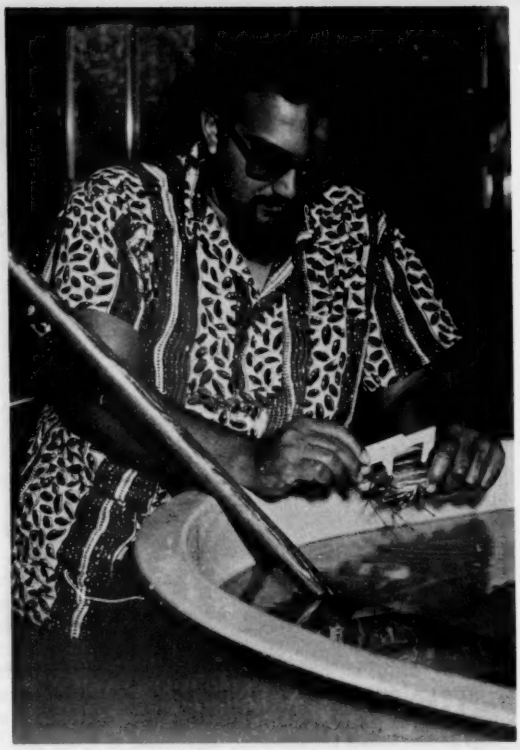

Fig. 4 - NOAA's Sea Grant Program supports research in marine aquaculture. These Puget Sound spot prawns are one of many valuable shellfish in the region that are being cultivated. Although research demonstrates that this crustacean is very hardy and relatively easy to culture in small numbers, techniques required for rearing the prawn for U.S. markets have not been determined.

Seaweed

The Pacific Northwest does not have a well-established seaweed industry, although its miles of coastline and inland waterways support one of the world's most diverse marine flora.

The Lummi Indians are experimenting with the harvesting of the red seaweed, Iridea

Fig. 5 - The Washington State Department of Natural Resources is studying the potential of marine plants native to Puget Sound. The Lummi Indians are harvesting large quantities of one species of marine plant in northern Puget Sound. If the proper substrates are placed in the water, young, free-floating plants will attach themselves and can be grown in dense profusion. These kelp attached themselves to a partially submerged board and grew over 4 feet long in less than 6 months.

cordata, in the San Juan Islands. If successful, this experiment may point the way to a valuable new industry for the region.

The Washington State Department of Natural Resources seeks to encourage the introduction of seaweed harvesting to supplement shellfish and salmon aquaculture. It has estimated that the standing crop of naturally occurring seaweeds in state waters is worth about $500,000 a year. Algologists at the University of Washington have suggested that this figure could be doubled, at least, by the development of appropriate culture methods.

SEA FARMING'S ROLE IN PREVENTING WATER POLLUTION

Other estuarine areas in the Puget Sound region can increase their potential for aquaculture by abating and controlling pollution and by a rational system of water-use zoning. Willapa Bay, Wash., the Columbia Estuary, and the estuaries of many coastal streams in Oregon could be considered for the development of sea farming.

Open-range salmon ranching appears to be an excellent prospect for the estuary of the Columbia and the Oregon coastal streams. Other types of sea farming in brackish water, in the mud flats, and in the channels of larger estuaries should be investigated.

Willapa Bay already supports an extensive oyster-farming industry. The quality of the Bay water, however, is being threatened by seepage of groundwater contaminated by a rapid increase in septic tanks from new residential developments. The adequacy of existing zoning regulations and authority to protect the oyster grounds is questionable.

Although severe inroads have already been made on the quality of the estuarine waters of the Pacific Northwest by unfortunate land-use practices, there still remains an enormous potential for aquaculture. We believe it is critical that a firm foothold be established in the shortest possible time. Extensive, privately controlled aquacultural crops will provide an economic incentive to abate and prevent pollution--and a sensitive and powerful tool for the continuous surveillance of water quality.

THE GROWING ROLE OF INTERNATIONAL AGREEMENTS IN ALASKAN FISHERIES

Ronald C. Naab

About 1,300 ships from Japan, the U.S.S.R., Canada, and South Korea annually fish in international waters off Alaska. These high-seas foreign fleets are capable of depleting the resources supporting Alaska's largely inshore commercial and marine sport fisheries. The United States Government has long recognized this threat. Increasingly, it has used international agreements, particularly bilateral agreements during the last several years, to protect vital U.S. fisheries off Alaska. These agreements are renegotiated frequently to accommodate changes in and further protect U.S. fisheries. Thus far, the U.S. has not sought an agreement with South Korea. Continued expansion of its fisheries, or recurrence of high-seas salmon fishing, could prompt such negotiations.

FOREIGN FLEETS

Alaska's commercial fisheries and a large segment of her marine sport fisheries (salmon angling) are jeopardized by foreign fleets fishing in offshore international waters. The marine resources largely supporting those fisheries, such as salmon, halibut, and king and tanner crab, range widely; during much of their life, they are in waters beyond the limits of U.S. fisheries jurisdiction (12 miles). Under present international law, the resources, while in high-seas waters, are subject to unrestricted fishing by any nation. This could deplete them before they return to Alaska's largely inshore fisheries. This threat is very real in the Alaskan area where, each year, Japan, the U.S.S.R., Canada, and most recently South Korea dispatch about 1,300 ships.

The United States has long recognized this threat. It has negotiated 10 international agreements designed to provide the needed protection. In earlier years, such agreements were multilateral conventions between the U.S. and two or more other nations aimed mainly at protecting the resources in international waters. Since the mid-1960s, there has been increasing use of bilateral agreements. These have been aimed at protecting the resources--and also the rights of the smaller U.S. coastal fishing vessels to operate in adjacent areas of the high seas when faced by the larger distant-water foreign fleets. (The development of international agreements affecting Alaskan fisheries was described in earlier articles in Commercial Fisheries Review: October 1968, pp. 46-56. Also Sep. No. 825. June 1969, pp. 30-34. Also Sep. No. 841.)

Constant changes are vital to the U.S. and foreign fleets off Alaska in their efforts to survive in highly competitive world fisheries. To facilitate changes by U.S. fishermen and to permit prompt corrective measures for stocks that appear overexploited, the U.S. has insisted that bilateral agreements be of short duration and be reexamined frequently. In 1970 and early 1971, the U.S. and Canada negotiated an agreement concerning reciprocal fishing off their coasts. The U.S. revised several agreements with Japan and the Soviet Union concerning fisheries off Alaska.

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COMMERCIAL FISHERIES REVIEW
Reprint No. 919

CANADIAN AGREEMENT

In November 1966, the U.S. enacted Public Law 89-658 establishing an exclusive 3- to 12-mile fishing zone (contiguous fishery zone or CFZ) adjacent to the territorial sea. The law provides for the continuation of these traditional foreign fisheries within the CFZ as may be recognized by the U.S. Canada enacted a similar law in 1964.

The only foreign nations having fisheries off Alaska which the U.S. could consider as "traditional" were Canada, Japan, and the U.S.S.R. Agreements concerning continuation of certain fisheries within the CFZ by Japan and the Soviet Union were negotiated in 1967 (see following sections). In April 1970, the U.S. and Canada concluded an agreement in Ottawa concerning reciprocal fishing privileges within their exclusive fishing zones.

Principal Features

The two-year agreement allows fishermen of both countries to continue those commercial fisheries they had conducted outside a line three miles from the coasts of the other country prior to establishment of exclusive fishing zones by either Canada or the U.S. It was agreed that:

(1) Salmon trolling by Canadians is permitted to continue in the U.S. 3- to 12-mile zone only off the coast of Washington. U.S. salmon trollers may fish in the Canadian zone only off Vancouver Island.

(2) Halibut fishing by either country may continue in the other's zone.

(3) Fishing for any species of crab, shrimp, scallop, clam, or lobster is not permitted in the other country's fishing zone.

(4) Neither country may fish for herring in the other's zone (transfers of herring on east coasts of Canada and the U.S. may continue).

(5) Such trawl fisheries as have been conducted in each country's fishing zone by vessels of the other country may continue.

(6) The initiation of new fisheries by one country within the fishing zone of the other requires consultation and agreement.

In my opinion, the overall effect of this agreement is advantageous to Alaskan fisheries. Only the longstanding Canadian halibut fishery which began off Alaska in 1913 is allowed to continue within the CFZ. The growing Canadian salmon trolling fleet is prohibited from competing with U.S. trollers within 12 miles of Alaska's coasts (Public Law 88-308 enacted in 1964 prohibits all foreign fishing within the U.S. 3-mile territorial sea). Canadian fishermen are denied access to Alaska's valuable inshore resources of king and tanner crab, shrimp, scallops, and herring. Finally, Canada must consult with and obtain permission from the U.S. if her fishermen want to fish for any species (other than halibut and the prohibited species listed above) within 3 to 12 miles off Alaska. This has great potential importance when you think of the latent resources near Alaska's coasts.

JAPANESE AGREEMENTS

U.S. and Japanese delegations met in Tokyo November 1970 to discuss the future of two agreements: (1) King and Tanner Crab Agreement and (2) Contiguous Fishery Zone Agreement. New agreements, effective for two years, 1971-1972, were signed on December 11, 1970.

King and Tanner Crab Agreement

Under the 1958 Geneva Convention of the Continental Shelf, the U.S. maintains that king and tanner crab are natural resources of the Continental Shelf. As a coastal state, the U.S. has exclusive jurisdiction over the management and use of these resources. Japan, a nonsignatory of the Convention, believes that king and tanner crab are high-seas resources and that its nationals are entitled to fish for them in international waters. At the first negotiation, in 1964, and later, both Governments agreed to set aside their positions without prejudice to their views and to seek practical solutions.

The 1964 agreement restricted Japanese king-crab fishing to the eastern Bering Sea.

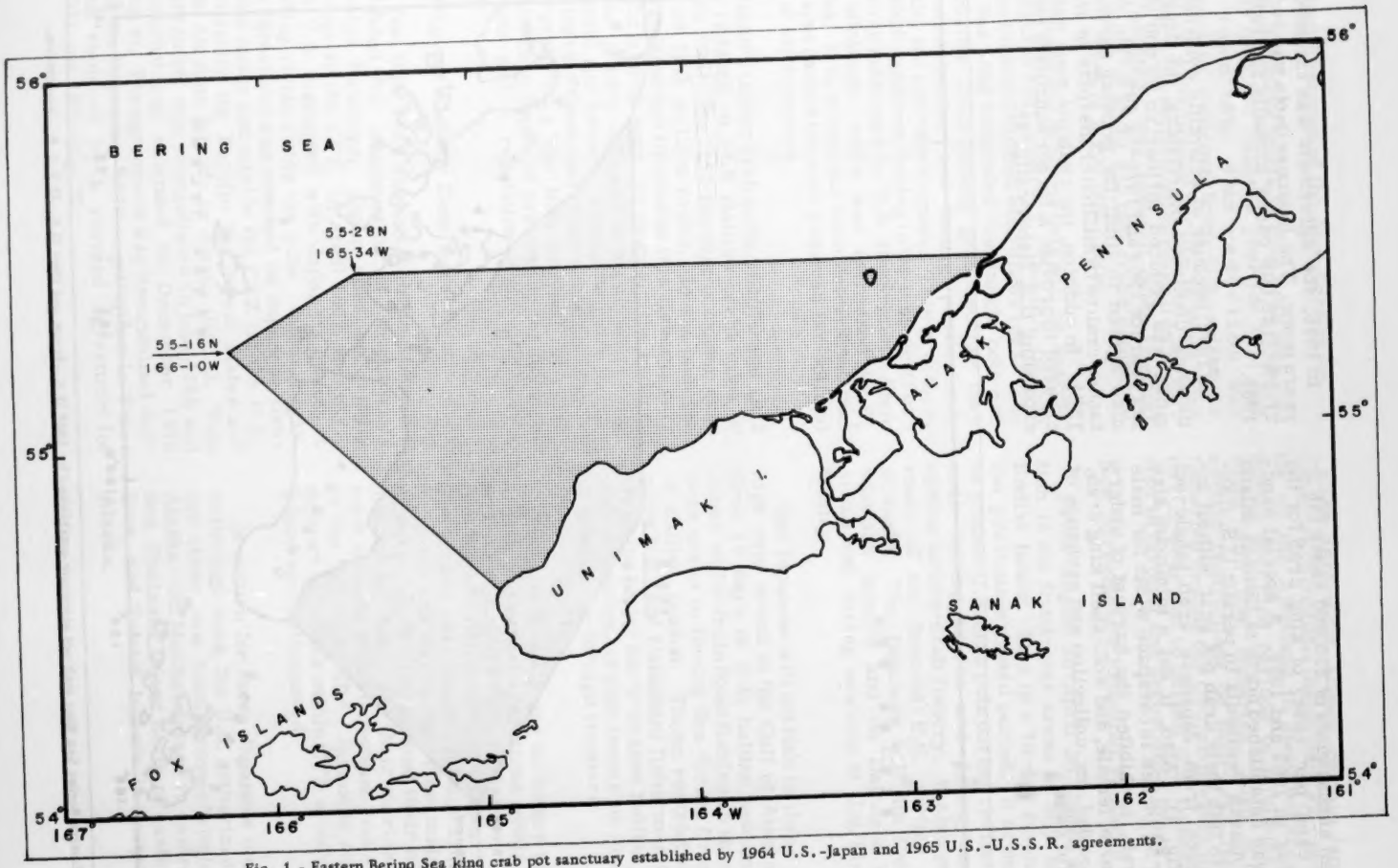


Fig. 1 - Eastern Bering Sea king crab pot sanctuary established by 1964 U.S.-Japan and 1965 U.S.-U.S.S.R. agreements.

It set an annual quota of 235,000 cases (48 ½-pound cans per case) of king crab for the Japanese in 1965 and 1966. A special sanctuary was established north of Unimak Island off the Alaska Peninsula to permit U.S. fishermen to fish their crab pot gear without interference from Japanese crab tangle-net gear (fig. 1). Also, it set a minimum size limit of 5¾ inches in carapace width for male king crab, prohibited the harvest of undersized male, female, and soft-shell king crab, and provided for collection and exchange of scientific data.

In 1966, the agreement was extended two years more. The Japanese quota was reduced 21.3%--185,000 cases annually for 1967 and 1968.

In 1968, because of scientific evidence indicating continued overfishing, the Japanese quota was reduced further to 85,000 cases per year for 1969 and 1970--a 48% cut. Japan also agreed to limit its growing harvest of tanner crab to 16 million crabs (plus or minus 15%). In addition, the crab pot zone was increased to provide a larger sanctuary for the expanding U.S. fishery (fig. 2).

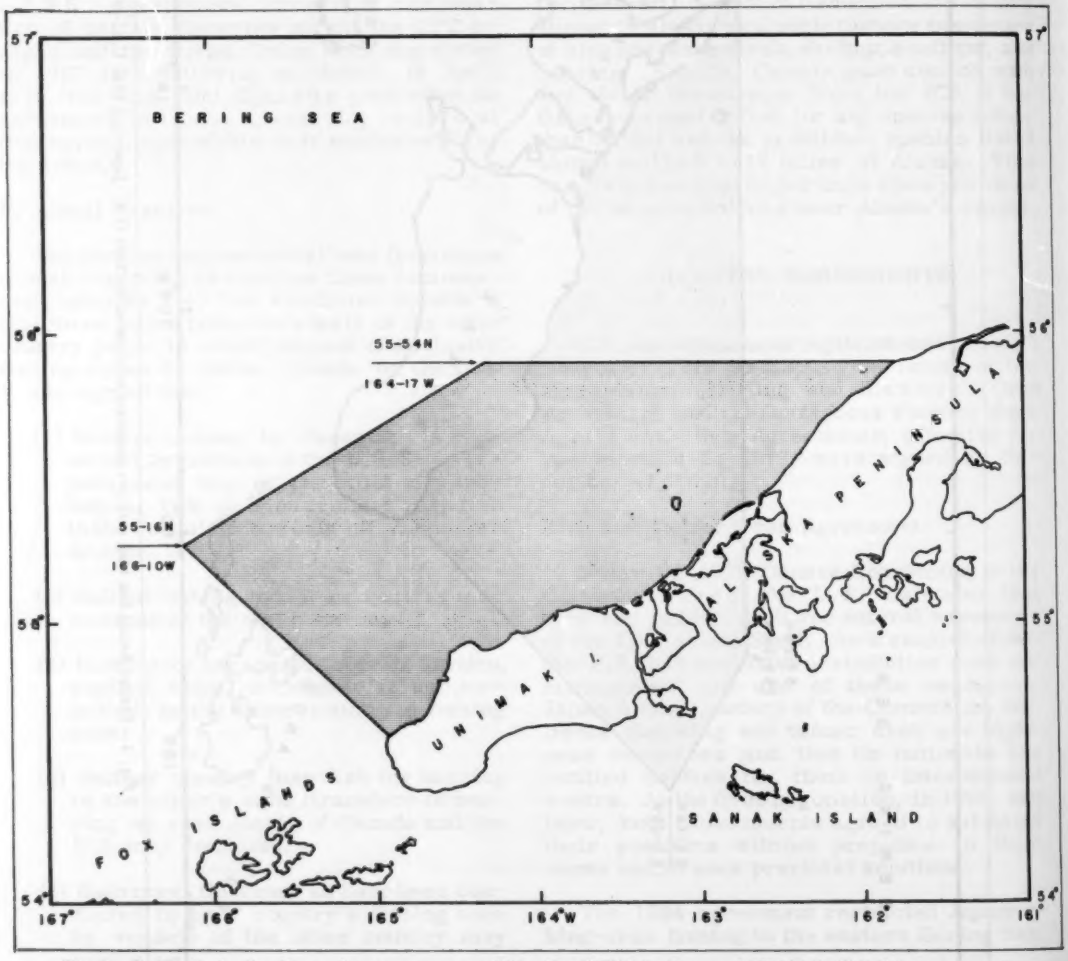


Fig. 2 - Eastern Bering Sea king crab pot sanctuary established by 1968 U.S.-Japan and 1969 U.S.-U.S.S.R. agreements.

Principal Features of the New Agreement

The Japanese quota of king crab was cut sharply to 37,500 cases a year for 1971 and 1972--down 56%. This reduction was prompted by evidence from U.S. scientists indicating a continuing decline in stock conditions despite conservation measures previously adopted. The reduced quota is equal to a catch of about 920,000 crabs compared to 1970 catch of 2,100,000 crabs.

Japanese use of tangle nets will be sharply curtailed in 1971 and 1972. The U.S. intends to have them eliminated entirely by 1973. The U.S. has long contended that tangle nets are destructive crab-fishing gear because they are nonselective and damage undersized, female, and soft-shell crabs. This provision will shift Japanese fishing to the less-destructive crab pots used by U.S. fishermen. Also, the minimum width was increased to $6\frac{1}{4}$ inches. U.S. scientists have determined that this approaches the size required for optimal use of the resource.

Japan's tanner crab quota in 1971 and 1972 was reduced to 14.6 million crabs (plus or minus 10%). Its 1970 harvest of tanner crab totaled 18.2 million crabs. In the past few years, Japan has increased this fishery, particularly with pots, to augment the reduced quotas of king crab and to supply increasing markets for tanner. Available evidence indicates that the tanner-crab resource may be overexploited. The U.S. pressed for catch reduction in hopes of preventing the tanner's decline and a repetition of the king crab's fate.

Contiguous Fishery Zone Agreement

The U.S. 1966 law establishing the CFZ provided for continuation of "traditional" foreign fisheries. Japan does not legally recognize the CFZ. In April 1967, in Tokyo, the U.S. discussed with Japan its claims to fishing rights within the zone. In early May, an agreement was reached on Japanese fisheries inside and outside the CFZ off the U.S., primarily the Pacific Northwest States and the Aleutian Islands in Alaska (fig. 3). This agreement was renegotiated in late 1968 and modified and extended to December 1970 (fig. 4). The agreement was reexamined during the November 1970 negotiations in Tokyo and replaced by a revised agreement for 1971 and 1970 (fig. 5).

The agreement allows certain Japanese fisheries to continue inside the CFZ--primarily off the Aleutians in specified areas and during specified periods to minimize conflicts with U.S. fisheries. Also, it places certain restrictions on high-seas Japanese fisheries beyond the CFZ to prevent damage to U.S. gear and to permit U.S. fishermen to fish in favored and accustomed areas.

New Agreement's Principal Features

From August 20-April 30, Japan will not fish in six fixed-gear areas on high seas off Kodiak Island. This is a 70-day extension of the previously closed period. It is designed to protect U.S. crab pots during revised king-crab fishing season and during emergent spring tanner-crab fishery. It also protects many of the favored U.S. shrimp fishing grounds. The Japanese will not fish along Aleutian Islands and on Davidson Bank in areas and during seasons of U.S. king-crab fishing.

The Japanese will not fish in three revised high-seas areas in the Gulf of Alaska during first 15 days of U.S. halibut season. Also, Japan will refrain from fishing in three high-seas areas in Bering Sea during first 6 days of halibut season. These restrictions will allow U.S. (and Canadian) fishermen to operate on the better early-season halibut grounds with less danger of gear losses or preemption of grounds by foreign trawlers.

Japanese vessels are no longer permitted to fish or support operations within CFZ off St. Paul Island in Pribilof Islands. Oil spills have been detected in the Pribilofs. Many fur seals have been found with discarded materials associated with fisheries (mainly pieces of webbing) entwined around their necks. To protect fur seals and their marine environment on this most important rookery island in the North Pacific, Japanese fishing and support activities within CFZ around St. Paul Island were eliminated.

In return for these Japanese concessions on the high seas, the U.S. authorized Japan to use three new loading zones within CFZ off Alaska--St. Matthew Island in central Bering Sea, Unalaska Island north of eastern Aleutians, and Semidi Islands in western Gulf of Alaska.

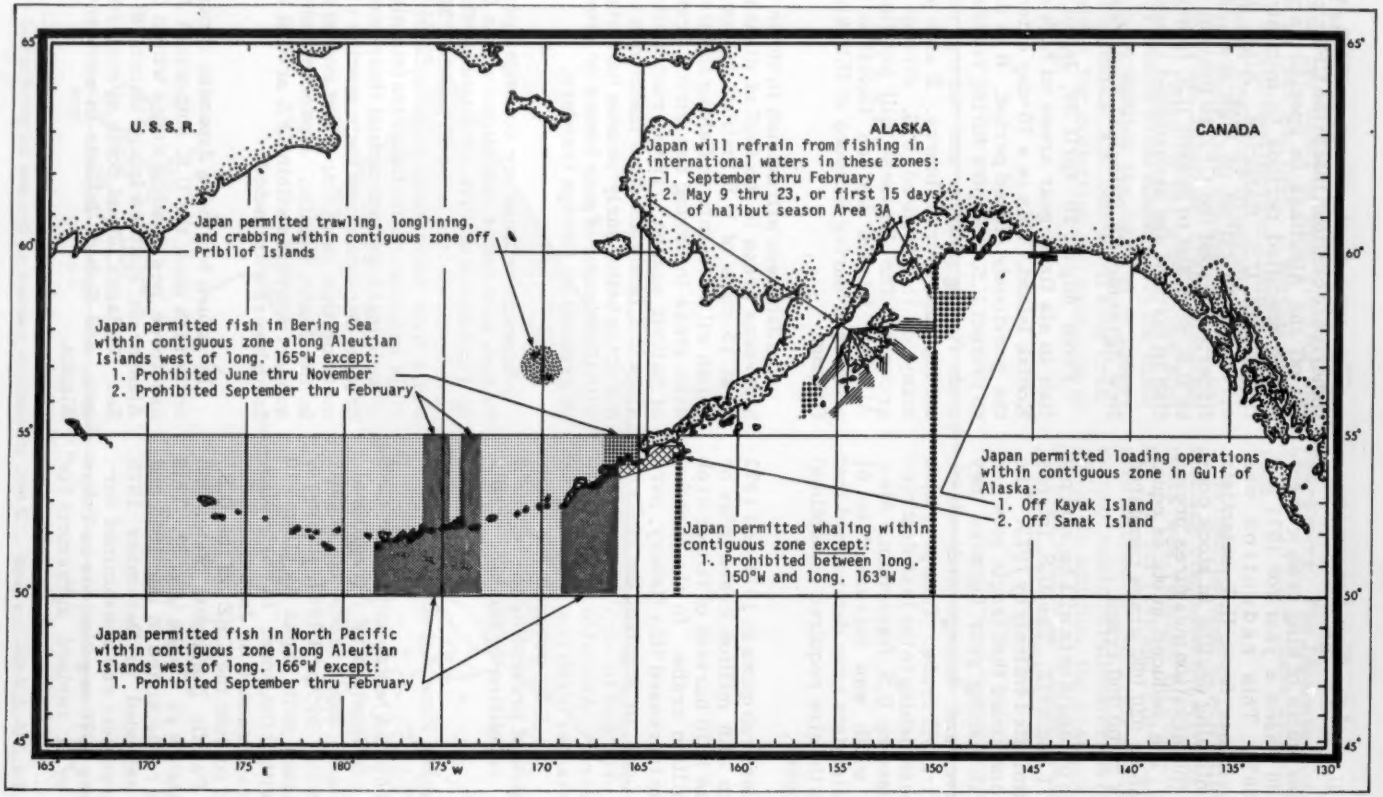

U.S.S.R.
ALASKA
CANADA
Japan will refrain from fishing in international waters in these zones:
1. September thru February
2. May 9 thru 23, or first 15 days of halibut season Area 3A
Japan permitted trawling, longlining, and crabbing within contiguous zone off Pribilof Islands
Japan permitted fish in Bering Sea within contiguous zone along Aleutian Islands west of long. 165°W except:
1. Prohibited June thru November
2. Prohibited September thru February
Japan permitted loading operations within contiguous zone in Gulf of Alaska:
1. Off Kayak Island
2. Off Sanak Island
Japan permitted whaling within contiguous zone except:
1. Prohibited between long. 150°W and long. 163°W
Japan permitted fish in North Pacific within contiguous zone along Aleutian Islands west of long. 166°W except:
1. Prohibited September thru February
65°
60°
55°
50°
45°
165°
170°
175° E
180°
175° W
170°
165°
160°
155°
150°
145°
140°
135°
130°

Fig. 3 - Fishing and loading areas off Alaska established by 1967 U.S.-Japan contiguous fishery zone agreement.

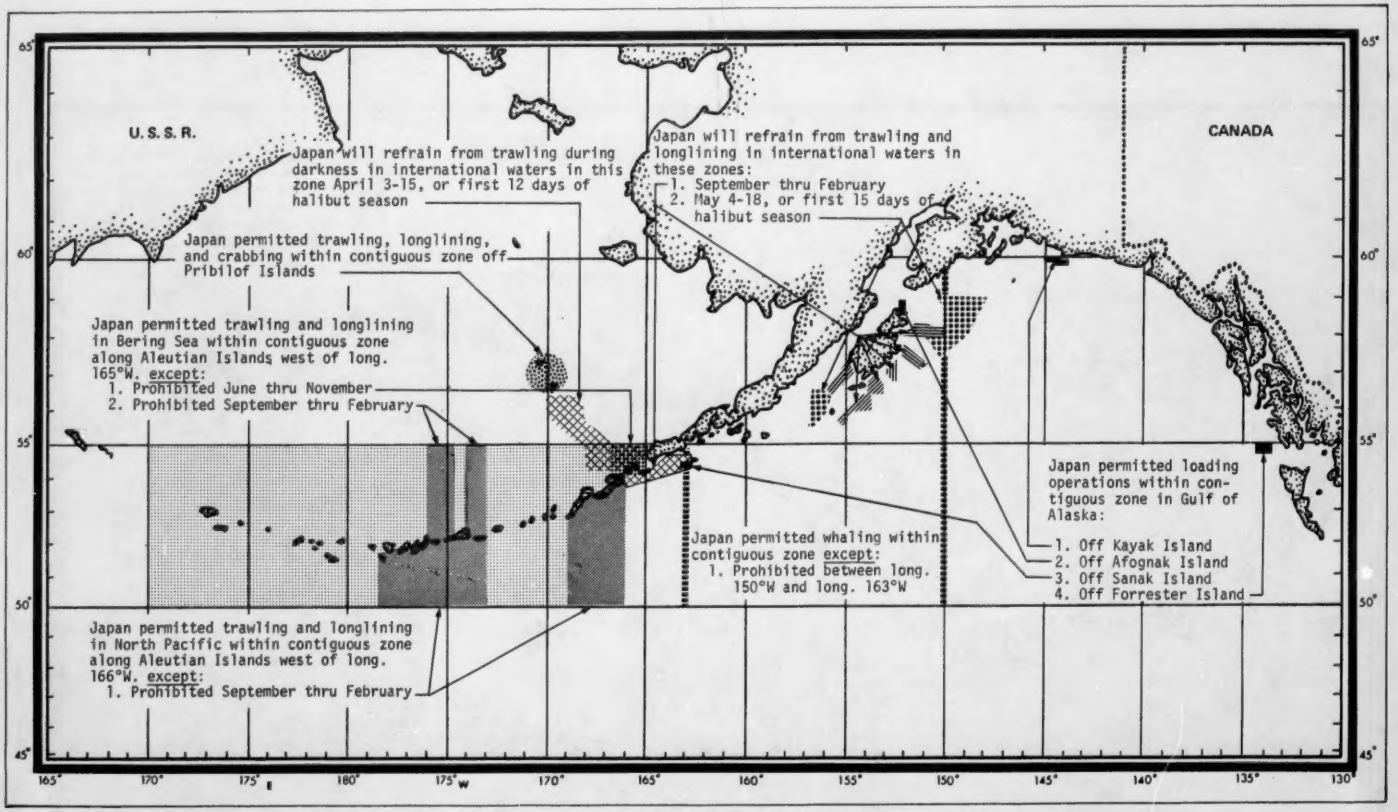

U.S.S.R.
CANADA
Japan will refrain from trawling during darkness in international waters in this zone April 3-15, or first 12 days of halibut season
Japan will refrain from trawling and longlining in international waters in these zones:
1. September thru February
2. May 4-18, or first 15 days of halibut season
Japan permitted trawling, longlining, and crabbing within contiguous zone off Pribilof Islands
Japan permitted trawling and longlining in Bering Sea within contiguous zone along Aleutian Islands west of long. 165°W. except:
1. Prohibited June thru November
2. Prohibited September thru February
Japan permitted loading operations within contiguous zone in Gulf of Alaska:
1. Off Kayak Island
2. Off Afognak Island
3. Off Sanak Island
4. Off Forrester Island
Japan permitted whaling within contiguous zone except:
1. Prohibited between long. 150°W and long. 163°W
Japan permitted trawling and longlining in North Pacific within contiguous zone along Aleutian Islands west of long. 166°W. except:
1. Prohibited September thru February
65°
60°
55°
50°
45°
165°
170°
175° E
180°
175° W
170°
165°
160°
155°
150°
145°
140°
135°
130°

Fig. 4 - Fishing and loading areas off Alaska established by 1968 U.S.-Japan contiguous fishery zone agreement.

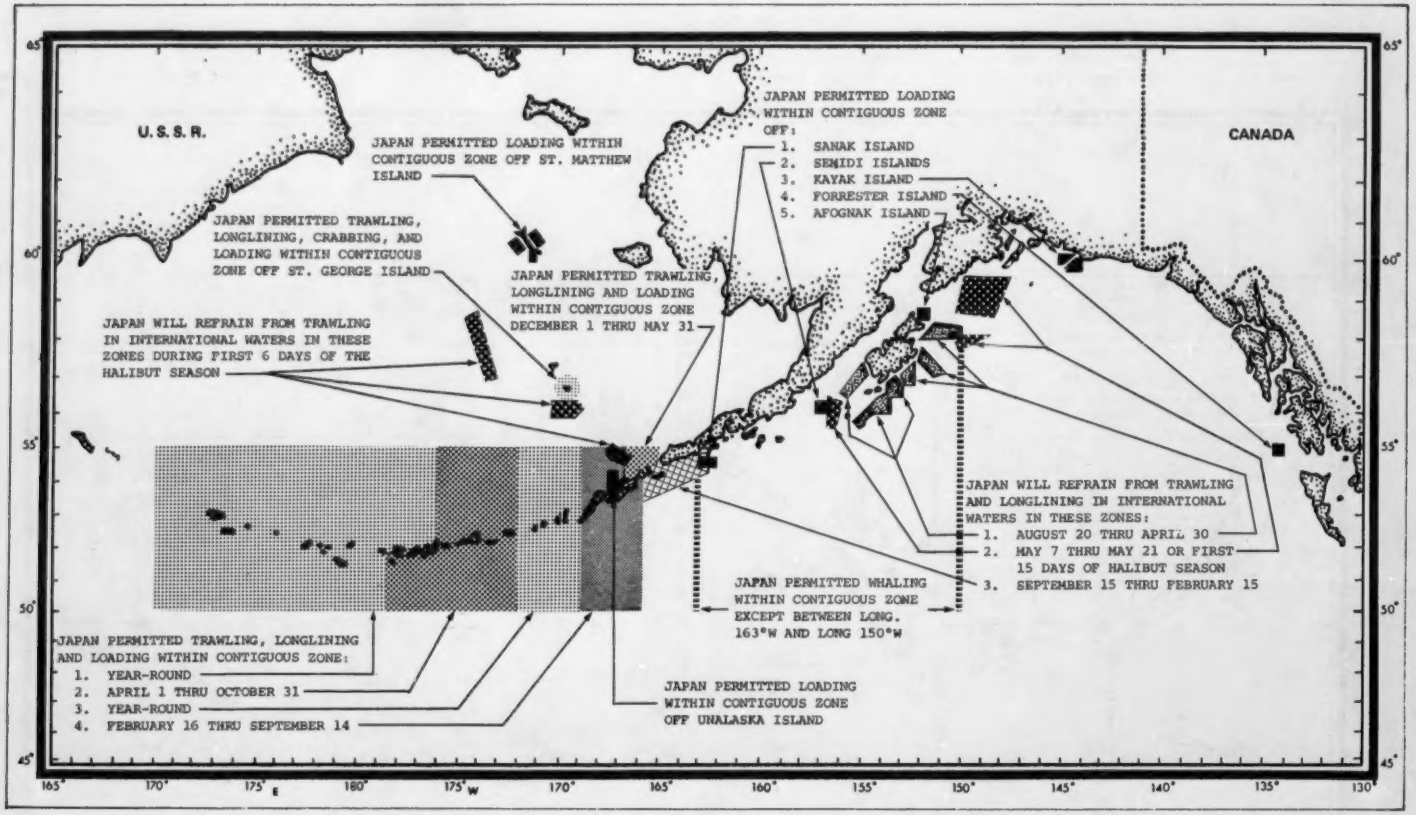

U.S.S.R.
CANADA
JAPAN PERMITTED LOADING WITHIN CONTIGUOUS ZONE OFF ST. MATTHEW ISLAND
JAPAN PERMITTED TRAWLING, LONGLINING, CRABBING, AND LOADING WITHIN CONTIGUOUS ZONE OFF ST. GEORGE ISLAND
JAPAN WILL REFRAIN FROM TRAWLING IN INTERNATIONAL WATERS IN THESE ZONES DURING FIRST 6 DAYS OF THE HALIBUT SEASON
JAPAN PERMITTED TRAWLING, LONGLINING AND LOADING WITHIN CONTIGUOUS ZONE DECEMBER 1 THRU MAY 31
JAPAN PERMITTED LOADING WITHIN CONTIGUOUS ZONE OFF:
1. SANAK ISLAND
2. SEMIDI ISLANDS
3. KAYAK ISLAND
4. FORRESTER ISLAND
5. AFOGNAK ISLAND
JAPAN WILL REFRAIN FROM TRAWLING AND LONGLINING IN INTERNATIONAL WATERS IN THESE ZONES:
1. AUGUST 20 THRU APRIL 30
2. MAY 7 THRU MAY 21 OR FIRST 15 DAYS OF HALIBUT SEASON
3. SEPTEMBER 15 THRU FEBRUARY 15
JAPAN PERMITTED WHALING WITHIN CONTIGUOUS ZONE EXCEPT BETWEEN LONG. 163°W AND LONG 150°W
JAPAN PERMITTED TRAWLING, LONGLINING AND LOADING WITHIN CONTIGUOUS ZONE:
1. YEAR-ROUND
2. APRIL 1 THRU OCTOBER 31
3. YEAR-ROUND
4. FEBRUARY 16 THRU SEPTEMBER 14
JAPAN PERMITTED LOADING WITHIN CONTIGUOUS ZONE OFF UNALASKA ISLAND
65°
60°
55°
50°
45°
165°
170°
175° E
180°
175° W
170°
165°
160°
155°
150°
145°
140°
135°
130°

Fig. 5 - Fishing and loading areas off Alaska established by 1970 U.S.-Japan contiguous fishery zone agreement.

SOVIET AGREEMENTS

U.S. and Soviet representatives met in Washington, D.C., January-early February 1971, to discuss future arrangements on three fishery agreements: (1) King and Tanner Crab; (2) "Kodiak" Gear Area; and (3) Contiguous Fishery Zone. New agreements, signed February 12, will remain in force for two years: 1971 and 1972.

King and Tanner Crab Agreement

Unlike Japan, the U.S.S.R. is a signatory to 1958 Convention on the Continental Shelf. It recognizes that king and tanner crab are natural resources of the Shelf over which the coastal states exercise sovereign rights. In February 1965, the U.S. concluded the first agreement with the Soviet Union to control its fishery for king crab on U.S. Continental Shelf. The agreements were patterned largely after crab pacts with Japan; however, they took into account the Soviet's shorter history of fishing and smaller catches. Japan began fishing king crab off Alaska in 1930 and had a high catch of 5.9 million crabs in 1964; the Soviet fishery began in 1959 and took a high of 3.4 million crabs in 1961.

The 1965 agreement permitted Soviet king-crab fishing to continue only in the eastern Bering Sea. It limited their catch to 118,600 cases (48 $\frac{1}{2}$-pound cans) annually for 1965 and 1966. As with Japan, the Soviet agreement also established a crab pot sanctuary north of Unimak Island (fig. 1). It prohibited the taking of undersized male, female, and soft-shell king crab, and provided for exchange of scientific data.

In 1967, the agreement was extended for 1967 and 1968. The annual Soviet quota was reduced to 100,000 cases--a 15.7% reduction.

In 1969, with evidence of continued overfishing, the U.S. further reduced the Soviet quota to 52,000 cases in 1969 and 1970. This was a 48% cut, the same as Japan's. Also, Soviet catches of tanner crab were limited to 40,000 cases annually, and the crab-pot sanctuary was enlarged (fig. 2).

Since crab quotas began in 1965, the Soviets have never taken their assigned quotas. In 1970, they packed 12,800 cases of king crab (25% of quota) and 38,000 cases of tanner crab (95% of quota). The Japanese have taken each year the full amounts allowed.

Principal Features of New Agreement

The annual Soviet quota of king crab for 1971 and 1972 was reduced to 23,000 cases from the previous 52,000-case quota. This 56% reduction, the same as Japan's, is an effort to arrest the continuing resource decline. The Soviets, however, have agreed to further limit production in 1971 and 1972 to level of their 1970 catch, or 12,800 cases.

Use of tangle nets by the Soviets will be reduced during 1971 and 1972. The U.S. view is that crab pots should replace the destructive tangle nets. The Soviets are aware of U.S. intentions to seek complete elimination of tangle nets beginning in 1973. Elimination of tangle nets is a major step for the Soviets: unlike Japan and U.S., they have not developed a pot fishery for crabs.

The Soviet quota of tanner crab will be 35,000 cases in 1971 and 1972, a reduction of 12.5% from previous quota of 40,000 cases. As with Japan, it was done to protect the resource.

The minimum size for male king crab was increased to $6\frac{1}{4}$ inches carapace width. This size will permit more productive use of the resource; it applies also to U.S. and Japanese fishermen. It was agreed, however, that the Soviets would not enforce the new size until 1973. Because the Soviets have not developed the capability to fish crab pots, they cannot reequip their vessels to reduce use of tangle nets in 1971. They agreed to concentrate on switching to pots in 1972.

Returning to the sea crabs under $6\frac{1}{4}$ inches, but over the previous $5\frac{3}{4}$-inch size caught in tangle nets, would be wasteful because they would most likely not survive. So the special exemption was agreed on. In return, the Soviets agreed to restrict their 1971 and 1972 catches of king crab to 1970 level of 12,800 cases, or 55.6% of their authorized quota.

"Kodiak" Gear Area Agreement

This agreement was concluded initially in 1964 to resolve continuing conflicts over the loss or destruction of U.S. king-crab pot gear by Soviet trawlers. Six areas adjacent to Kodiak, favored U.S. grounds, were established. The operation of mobile fishing gear (trawls) was prohibited there during the U.S.

season (fig. 6). The six zones were seaward of U.S. 3-mile territorial sea and included large areas of the high seas or international waters. Later, these areas were protected from Japanese trawling by the 1967 CFZ Agreement with Japan. The initial agreement excluded trawling by small shrimp craft so development of a U.S. fishery on known shrimp stocks in Kodiak Island area would not be impeded.

The agreement was effective in substantially reducing gear conflicts; at later negotiations, it was extended and revised. Major revisions were adjustment of period during which trawling was prohibited to reflect changes in U.S. season and exclusion of U.S. scallop-fishing vessels from trawling prohibitions to facilitate emergent Alaskan scallop fishery.

Principal Features of New Agreement

Descriptions of the six areas were adjusted to eliminate small segments of CFZ previously included. These changes eliminate previous possibility of Soviet trawling in these areas within the 3- to 12-mile zone. These CFZ segments now support large U.S. fisheries for king crab, tanner crab, and shrimp. Since initial agreement preceded 1966 establishment by U.S. of a CFZ, the Soviets under previous agreement could have trawled within 3- to 12-mile zone during open season in the six areas. Although the Soviets did not trawl, this revision removes the possibility. This is particularly desirable because of increasing Soviet interest in shrimp fishing off Kodiak.

The period closed to trawling in three of the six areas (1, 2, and 4 on fig. 6) was

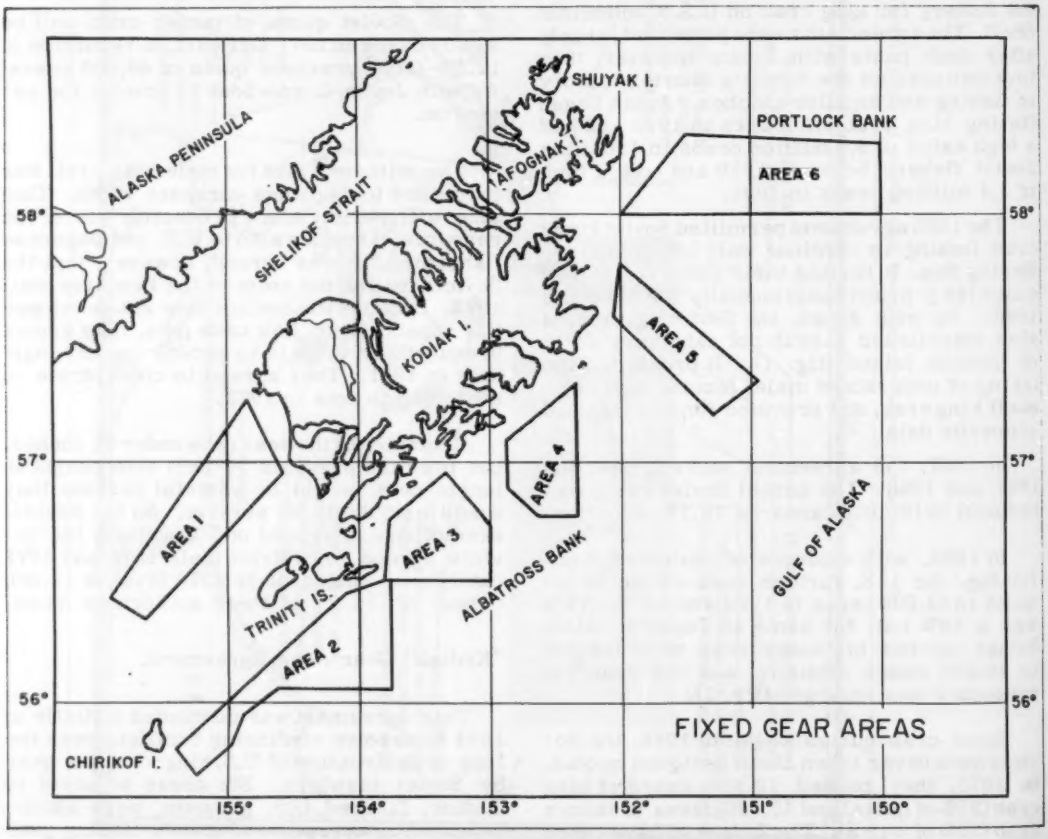


Fig. 6 - Fixed fishing gear areas established by 1964 U.S.-U.S.S.R. agreement.

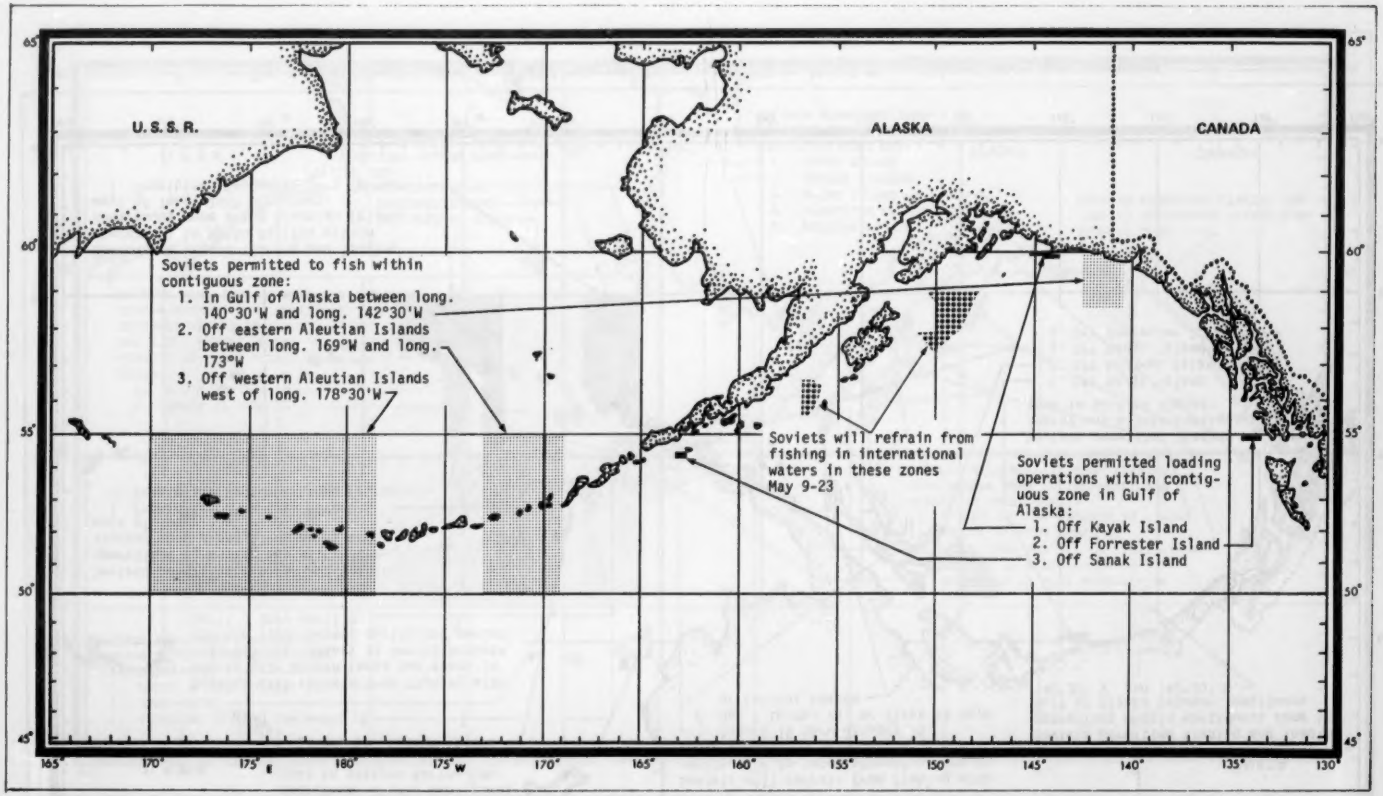


Fig. 7 - Fishing and loading areas off Alaska established by 1967 U.S.-U.S.S.R. contiguous fishery zone agreement.

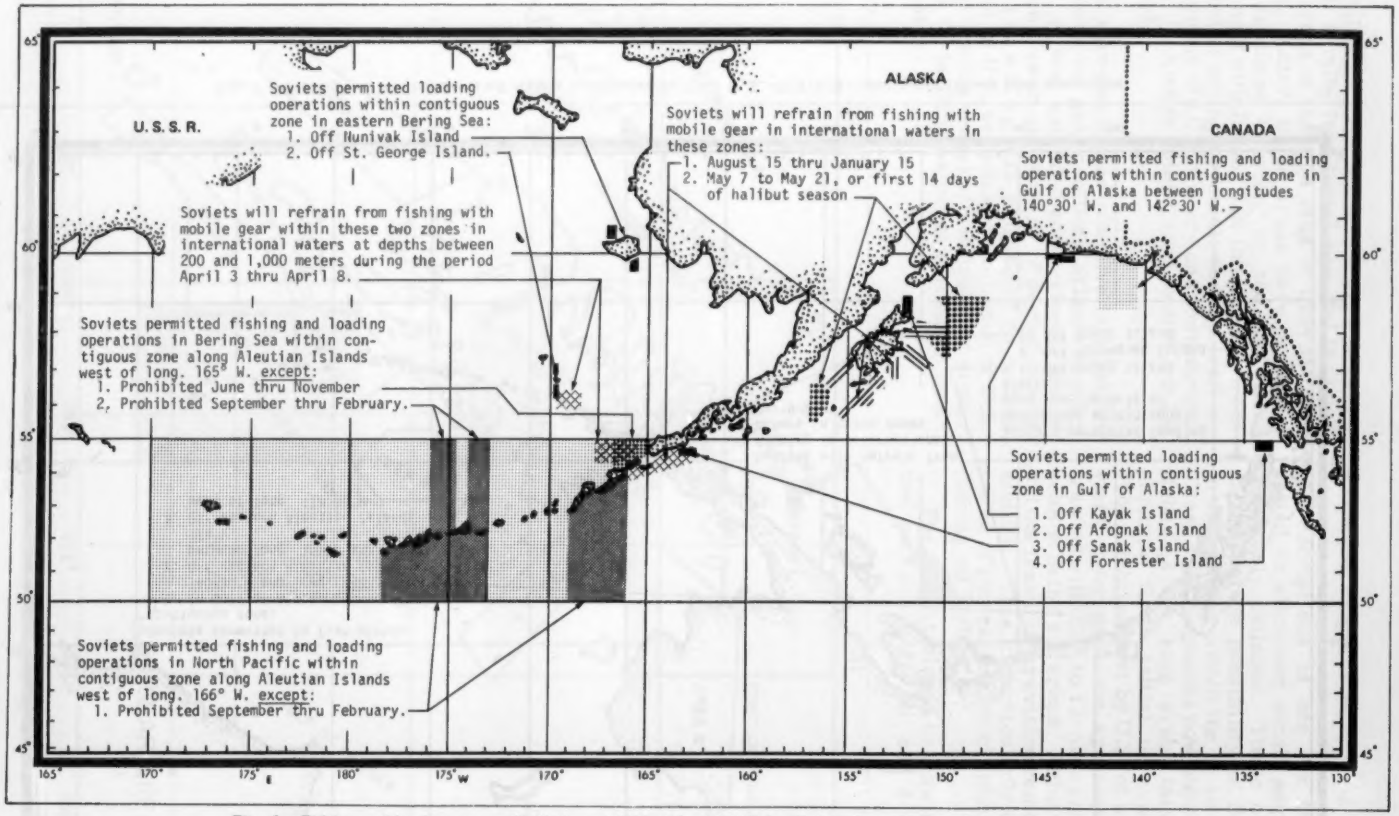

U.S.S.R.
ALASKA
CANADA
Soviets permitted loading operations within contiguous zone in eastern Bering Sea:
1. Off Nunivak Island
2. Off St. George Island.
Soviets will refrain from fishing with mobile gear within these two zones in international waters at depths between 200 and 1,000 meters during the period April 3 thru April 8.
Soviets permitted fishing and loading operations in Bering Sea within contiguous along Aleutian Islands west of long. 165° W. except:
1. Prohibited June thru November
2. Prohibited September thru February.
Soviets permitted fishing and loading operations in North Pacific within contiguous zone along Aleutian Islands west of long. 166° W. except:
1. Prohibited September thru February.
Soviets will refrain from fishing with mobile gear in international waters in these zones:
1. August 15 thru January 15
2. May 7 to May 21, or first 14 days of halibut season
Soviets permitted fishing and loading operations within contiguous zone in Gulf of Alaska between longitudes 140°30' W. and 142°30' W.
Soviets permitted loading operations within contiguous zone in Gulf of Alaska:
1. Off Kayak Island
2. Off Afognak Island
3. Off Sanak Island
4. Off Forrester Island
65°
60°
55°
50°
45°
165°
170°
175° E
180°
175° W
170°
165°
160°
155°
150°
145°
140°
135°
130°

Fig. 8 - Fishing and loading areas off Alaska established by 1969 U.S.-U.S.S.R. contiguous fishery zone agreement.

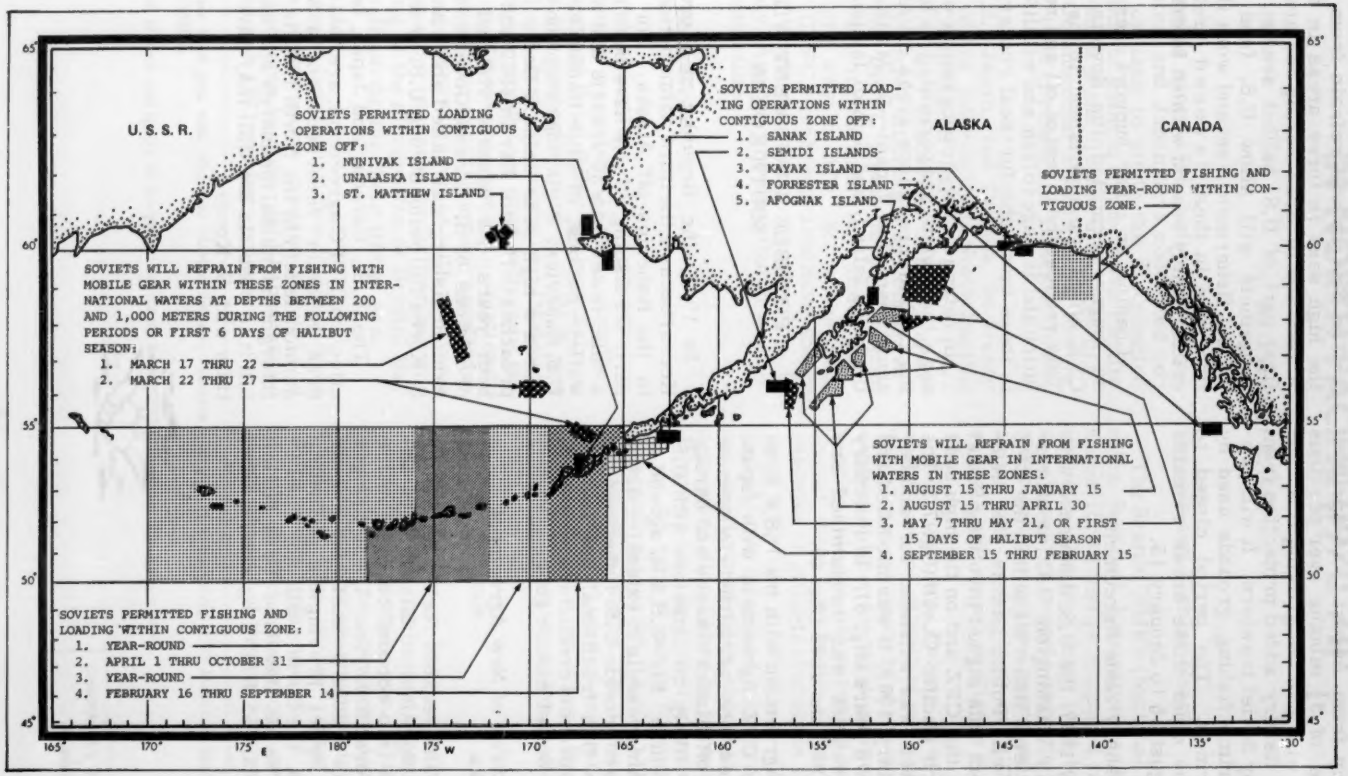

U.S.S.R.
ALASKA
CANADA
SOVIETS PERMITTED LOADING OPERATIONS WITHIN CONTIGUOUS ZONE OFF:
1. NUNIVAK ISLAND
2. UNALASKA ISLAND
3. ST. MATTHEW ISLAND
SOVIETS PERMITTED LOADING OPERATIONS WITHIN CONTIGUOUS ZONE OFF:
1. SANAK ISLAND
2. SEMIDI ISLANDS
3. KAYAK ISLAND
4. FORRESTER ISLAND
5. AFOGNAK ISLAND
SOVIETS PERMITTED FISHING AND LOADING YEAR-ROUND WITHIN CONTIGUOUS ZONE.
SOVIETS WILL REFRAIN FROM FISHING WITH MOBILE GEAR WITHIN THESE ZONES IN INTERNATIONAL WATERS AT DEPTHS BETWEEN 200 AND 1,000 METERS DURING THE FOLLOWING PERIODS OR FIRST 6 DAYS OF HALIBUT SEASON:
1. MARCH 17 THRU 22
2. MARCH 22 THRU 27
SOVIETS WILL REFRAIN FROM FISHING WITH MOBILE GEAR IN INTERNATIONAL WATERS IN THESE ZONES:
1. AUGUST 15 THRU JANUARY 15
2. AUGUST 15 THRU APRIL 30
3. MAY 7 THRU MAY 21, OR FIRST 15 DAYS OF HALIBUT SEASON
4. SEPTEMBER 15 THRU FEBRUARY 15
SOVIETS PERMITTED FISHING AND LOADING WITHIN CONTIGUOUS ZONE:
1. YEAR-ROUND
2. APRIL 1 THRU OCTOBER 31
3. YEAR-ROUND
4. FEBRUARY 16 THRU SEPTEMBER 14
65°
60°
55°
50°
45°
165°
170°
175° E
180°
175° W
170°
165°
160°
155°
150°
145°
140°
135°
130°

Fig. 9 - Fishing and loading areas off Alaska established by 1971 U.S.-U.S.S.R. contiguous fishery zone agreement.

changed to run from August 15 to April 30. This increase of $3\frac{1}{2}$ months over previous closed period will give the growing U.S. tanner crab pot fishery added protection from interference by Soviet trawlers. It will protect many shrimp fishing grounds used by Kodiak fishermen. The period closed to trawling in the other three areas remains the same, August 15 to January 15.

Contiguous Fishery Zone Agreement

In February 1967, the U.S. discussed with the U.S.S.R. in Washington, D.C., continuation of the latter's fisheries within the CFZ in accordance with Public Law 89-658. A 1-year agreement was signed involving Soviet fishing within the CFZ and on the high seas in northeastern Pacific Ocean (fig. 7). The agreement later was extended for another year. In January 1969, it was modified and extended for two years (fig. 8). In February 1971, the agreement was reexamined and replaced for 1971 and 1972 (fig. 9).

The CFZ Agreement with the U.S.S.R. is similar to the CFZ Agreement with Japan. Soviet fisheries are permitted to operate within the CFZ off Alaska in areas and during periods least likely to interfere with U.S. fishing. In return, the U.S.S.R. agreed to restrict its fishing vessels in extensive areas of the high seas to provide U.S. fishermen the opportunity to fish traditional and favored grounds and to prevent conflicts between U.S. fixed gear and Soviet mobile gear.

Principal Features of New Agreement Affecting Alaska

The areas and seasons for Soviet fishing within CFZ along Aleutian Islands were adjusted to take into account changes in the pattern of U.S. crab fisheries. These changes are designed to reduce possibilities of gear conflicts and Soviet preemption of fishing grounds. Also, the Soviets will not trawl in a high-seas area on Davidson Bank during the recently changed U.S. king crab fishing season.

The Soviets will refrain from fishing on the high seas in three areas in the Gulf of Alaska and in three Bering Sea areas during first part of U.S. halibut season. This arrangement will allow U.S. (and Canadian) halibut fishermen to set and work their longline gear in these favored areas during critical early season without interference.

Loading or other support operations are no longer permitted the Soviets within the CFZ off St. George Island in the Pribilofs. This reduces the threat of oil and refuse pollution and damage to fish and wildlife habitats in these invaluable fur-seal rookery islands.

In return for their concessions on the high seas, the Soviets are permitted to load within the CFZ in three more areas off Alaska (the same granted to Japan)--St. Matthew Island, Unalaska Island, and Semidi Islands.

POSSIBLE AGREEMENT WITH SOUTH KOREA

In 1967, the Republic of Korea (South Korea) became the third Asian nation engaged in the fisheries off Alaska. For the most part, its fishing efforts have been relatively small: fewer than 30 vessels and mainly for walleye pollock, of little immediate value to U.S. fisheries. A glaring exception was South Korea's high-seas salmon fleets in the approaches to Bristol Bay in 1969 and 1970. In both years, its vessels violated licensing provisions of S. Korean Government. The salmon fishery was halted and withdrawn by S. Korea following strong U.S. protests.

The U.S., Canada, and Japan, because of effect on INPFC agreement, are taking measures to deter recurrence of a S. Korean salmon fishery in the North Pacific. If these intergovernmental measures are unsuccessful, it is possible the U.S. may have to negotiate with S. Korea.

U.S. & JAPAN CONTINUE COOPERATIVE RESEARCH IN NORTH PACIFIC (1970-71)

R. Bakkala and R. French

Each spring since 1968, scientists of the United States and Japan have conducted cooperative cruises to study the distribution and migration of salmon in the North Pacific Ocean. Results of the first cruise were presented in Commercial Fisheries Review December 1968 (French and Bakkala, 1968).

The U.S., Japan, and Canada, as treaty members of the International North Pacific Fisheries Commission (INPFC), conduct research on fishery resources of common interest for effective utilization and conservation. In the INPFC treaty of 1953, Japan agreed to limit its commercial salmon fishing to waters west of 175° W. Since then, studies by INPFC member nations have shown that some sockeye salmon originating in Bristol Bay, Alaska, are distributed west of the abstention line.

Principal Objectives

Principal objectives of the cooperative spring cruises were to: (1) study distribution of maturing* Bristol Bay sockeye salmon relative to the abstention line at 175° W just prior to their inshore migration; (2) define oceanographic conditions that influence the distribution of sockeye salmon in relation to the abstention line; and (3) combine knowledge from spring research cruises with that from cruises in other seasons to further our understanding of the movements of Bristol Bay sockeye salmon during their life at sea.

This report briefly outlines findings from the earlier cooperative cruises in 1968 and 1969. It presents in more detail the results of the 1970 and 1971 spring cruises.

Vessels and Fishing Gear

The Seattle NMFS (National Marine Fisheries Service) Laboratory's RV 'George B. Kelez' (550 tons) participated in the four cooperative cruises from 1968 to 1971. Japanese research vessels were the 'Hokko Maru' (220 tons) during the 4 years and the 'Wakashio Maru' (150 tons) in 1968 and 1971. The three vessels are shown in Figure 1.

The primary fishing gear was surface multifilament gillnets of various mesh sizes. The Japanese vessels also used longlines to capture salmon for tagging experiments. The tagging data are not reported here. The U.S. vessel fished a basic string of 30 to 32 shackles of gillnets (1 shackle is 91.5 meters long) with five mesh sizes--63, 83, 98, 115, and 133 mm stretched measure. Experimental sections of deep nets and monofilament nets were also fished at various times. The Japanese usually fished a basic net string of 50 or 75 tans (1 tan is 50 meters long) with five mesh sizes--55, 72, 93, 121, and 157 mm stretched measure. In 1971, the 'Wakashio Maru' fished 25 tans of regular multifilament gillnets of 10 mesh sizes. Results reported here are of catches in the multifilament gillnets.

Communications

The language barrier between U.S. and Japanese scientists was overcome by means of the International Code. This allowed vessel activity to be coordinated and daily salmon catches and oceanographic data to be exchanged. The 'Kelez' also communicated daily via single side band radio with the Seattle NMFS Laboratory, sending data on catch results of the various vessels.

The authors are biologists with National Marine Fisheries Service, Biological Laboratory, 2725 Montlake Boulevard East, Seattle, Washington 98102.

*Maturing fish mature and spawn in the year of capture; immatures spawn one or two years later.

COMMERCIAL FISHERIES REVIEW
Reprint No. 920

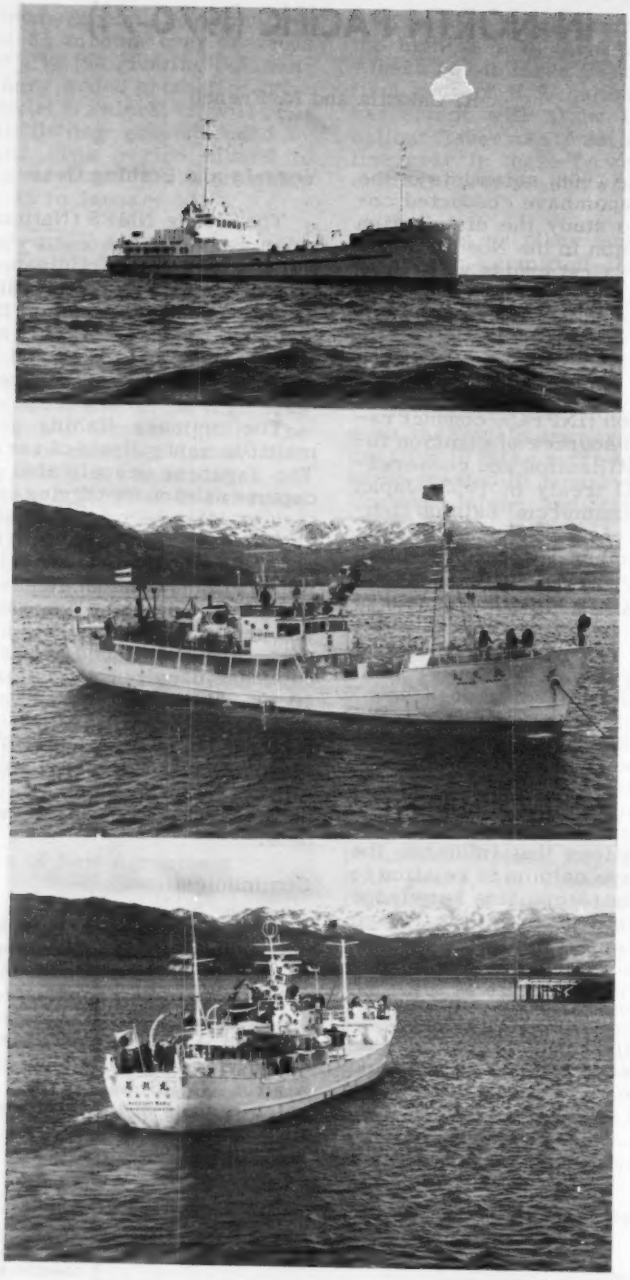


Fig. 1 - Research vessels participating in cooperative cruises--'George B. Kelez' (U.S.) and 'Hokko Maru' and 'Wakashio Maru' (Japan).

Following the cruises, scientists from the two nations met in Adak, Alaska, to exchange biological and oceanographic data.

RESULTS OF EARLIER STUDIES IN 1968-69

In the initial years of the cooperative cruises (1968 and 1969), the method of study involved fishing in a north-south direction for maturing sockeye salmon at various longitudes prior to their inshore migration (Figure 2). The fishing sites generally bracketed the area where tagging experiments have indicated that Bristol Bay sockeye salmon dominate the spring catches. These catch data allowed us to investigate the north-south distribution of maturing fish and their location in relation to various water masses and currents in the North Pacific Ocean; also, to gain some insight into the relative abundance and migrations of sockeye in relation to the abstention line at 175° W.

From these investigations and from the analyses of past tagging studies, several conclusions were reached on the distribution and migration of Bristol Bay sockeye in the spring (see Figure 2 for location of oceanographic features and other areas discussed):

1. Maturing fish are located in a broad band across the North Pacific Ocean from about 140° W to 170° E. They commence their inshore migration simultaneously from many points along this distribution.

2. This broad east-west band of maturing fish is found primarily in Ridge Area and Western Subarctic Intrusion Area waters in April and May.

3. The relative strength and continuity of the Alaskan Stream were previously hypothesized to influence the extent of westward migration by maturing sockeye salmon in late spring. Now they are tentatively considered to have little or no direct influence on migration routes in this time period. Maturing fish did not enter the Alaskan Stream until late May or early June when they were en route to Bristol Bay. They must have moved directly into the Bering Sea to have reached the Bay in their usual precise timing.

4. That portion of the maturing Bristol Bay stock east of 165° W primarily enter the Bering Sea through eastern Aleutian passes (east of 175° W). They are not vulnerable to the Japanese mothership fishery. Those fish between 165° W and 175° W in early spring are more vulnerable to the Japanese fishery because many of them migrate westward past the central Aleutian Islands to enter the Bering Sea through central or western Aleutian passes.

From these findings, we have hypothesized that the distribution of maturing sockeye in April and early May governs their routes of inshore migration--and their vulnerability to the Japanese fishing fleet in late May and June. In 1970 and 1971, the cruise pattern for the 'Kelez' was changed from the north-south track to an east-west track. This was designed to provide fishing stations through the main concentrations of maturing sockeye salmon and to test this hypothesis. The Japanese vessels continued their north-south pattern and provided data on the distribution of salmon west of the area covered by the U.S. vessel.

Although data from a series of years will be required to accomplish the major objectives of the study, some findings have immediate benefit. The cruises provide a forecast in May of the relative abundance and age composition of the Bristol Bay run--most of which occurs in early July--and an indication of the average size of the fish making up the run.

RESULTS OF STUDIES IN 1970-71

Distribution of Salmon

Sockeye and chum salmon were the main species taken in waters north of 49° N in April and May. Other species of salmon were seldom caught in this area. Earlier studies have shown that main concentrations of pink and coho salmon are in more southern waters (French, Bakkala, Osako, and Ito, 1971). The maturing chinook salmon that may be headed for western Alaska rivers are usually not taken in the mesh sizes used by the research vessels.

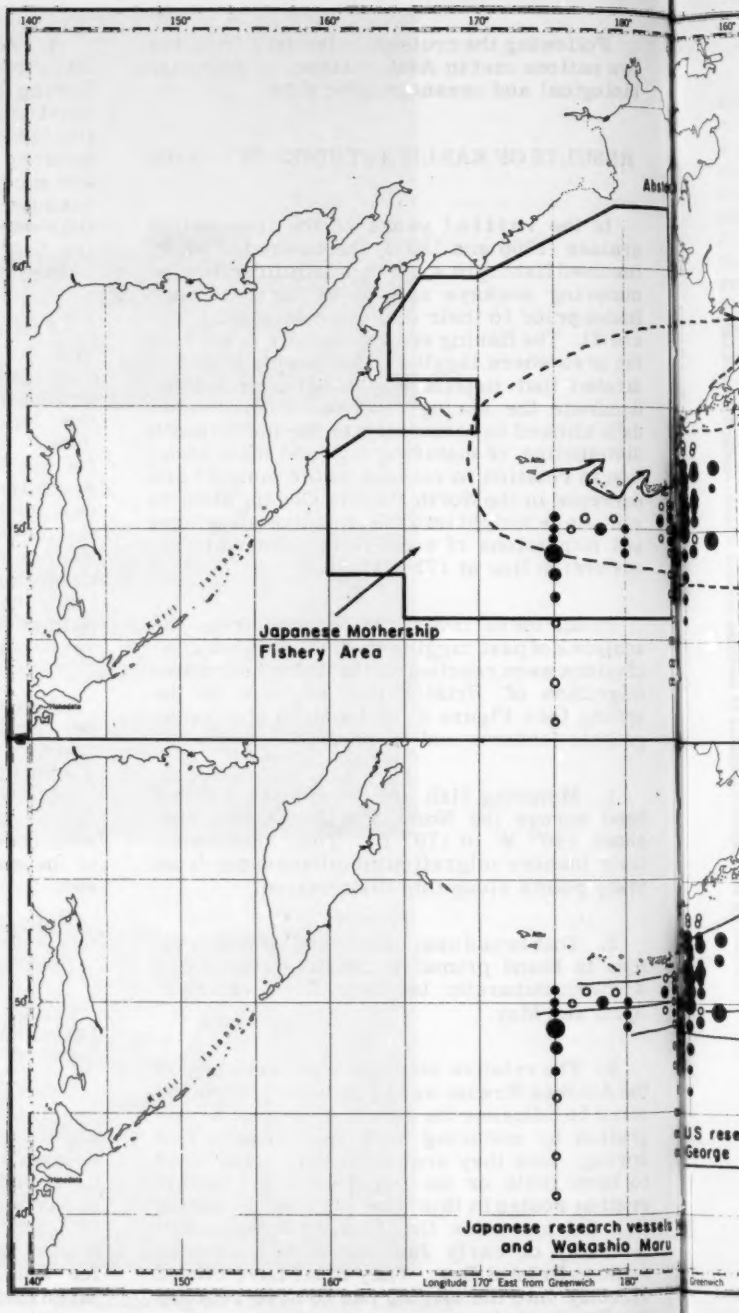
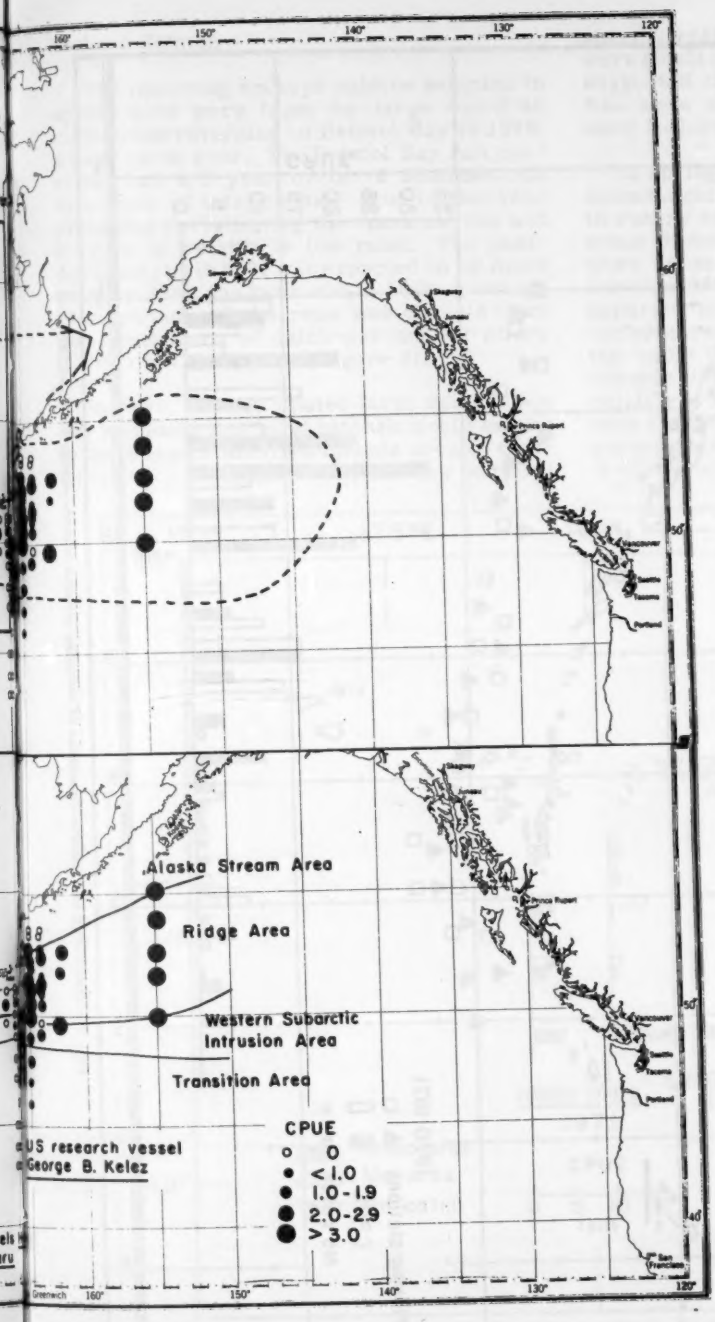


Fig. 2 - Distribution of maturing sockeye salmon in April and May of 1968 and 1969 in relation to the known limits of distribution and migration routes for maturing Bristol Bay sockeye salmon and in relation to the Japanese mothership fishing area, abstention line, and oceanographic features.


160°
150°
140°
130°
120°
60°
50°
40°
Alaska Stream Area
Ridge Area
Western Subarctic
Intrusion Area
Transition Area
US research vessel
George B. Kelez
CPUE
0
< 1.0
1.0 - 1.9
2.0 - 2.9
> 3.0
Greenwich
160°
150°
140°
130°
120°

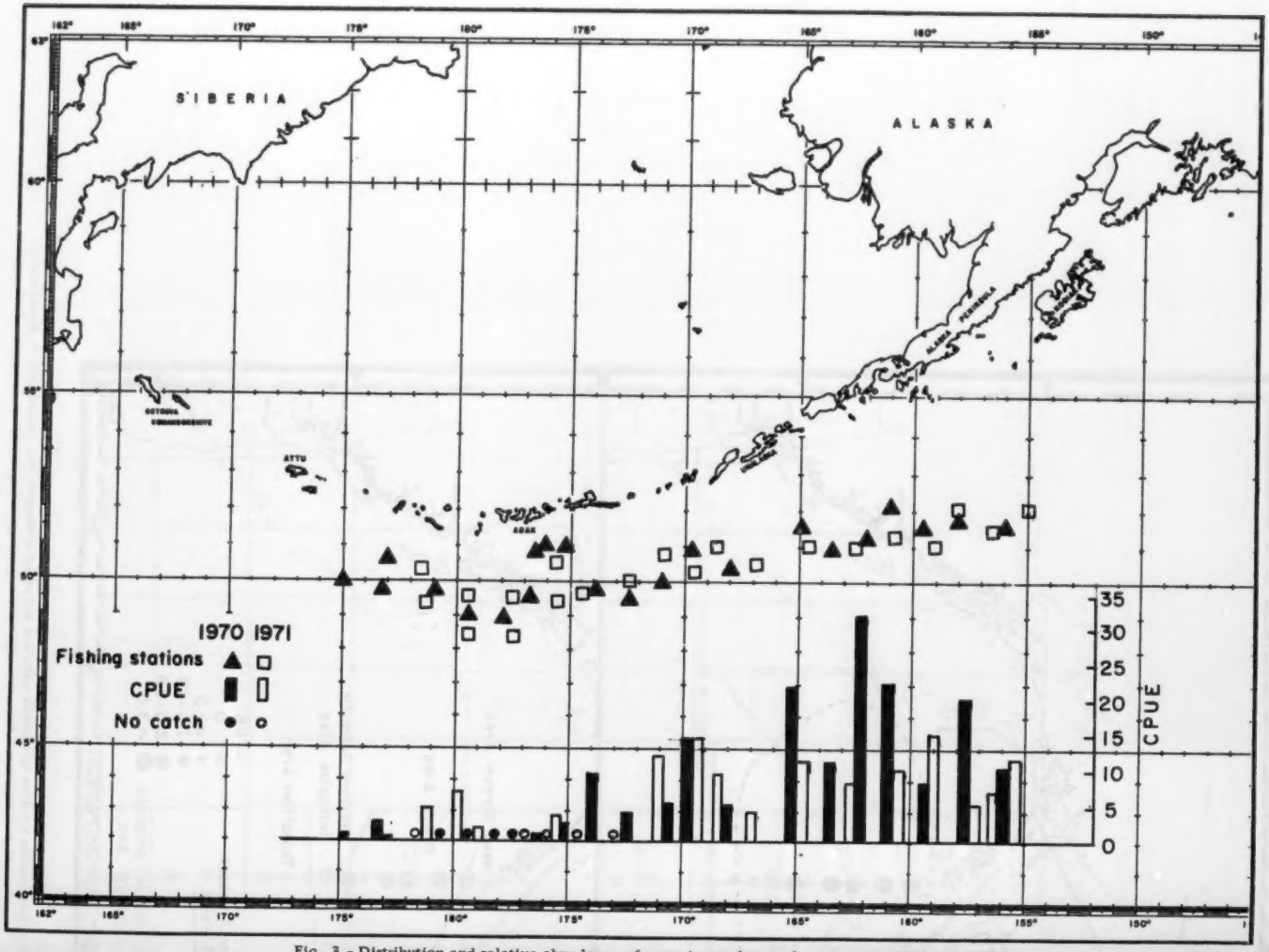


Fig. 3 - Distribution and relative abundance of maturing sockeye salmon--spring 1970 and 1971.

Sockeye Salmon

The maturing sockeye salmon sampled in spring 1970 were from the large run of 40 million fish returning to Bristol Bay in 1970, a peak cycle year. The Bristol Bay run currently has a 5-year cycle--a dominant run with runs of intermediate size in the year preceding and following the dominant run and 2 years of relatively low runs. The post-dominant run in 1971 was expected to be much smaller than the peak run in 1970; a change in magnitude of the runs was obvious from the comparison of catch-per-unit-of-effort (CPUE) in the 2 years (Figure 3).

In 1970, we anticipated large catches but had assumed that good catches would extend to the western Aleutian Islands areas. Contrary to these expectations, catches declined sharply west of 175° W, where gillnet catches were small or frequently zero. These findings suggested that the majority of Bristol Bay fish were east of the abstention line before their inshore migration.

In spring 1971, the distribution of sockeye salmon again appeared to be largely restricted to waters east of 175° W (Figure 3), although some differences from the 1970 distribution were apparent. The sharp peak in catches between 160° W and 165° W in 1970 was not apparent in 1971, when abundance was more uniform from 155° W to 170° W. In addition, the catch data from the Japanese research vessels indicated that maturing fish were relatively more abundant near 180° in 1971 than in 1970. These changes, however, do not substantially alter the general similarities of distribution between 1971 and 1970.

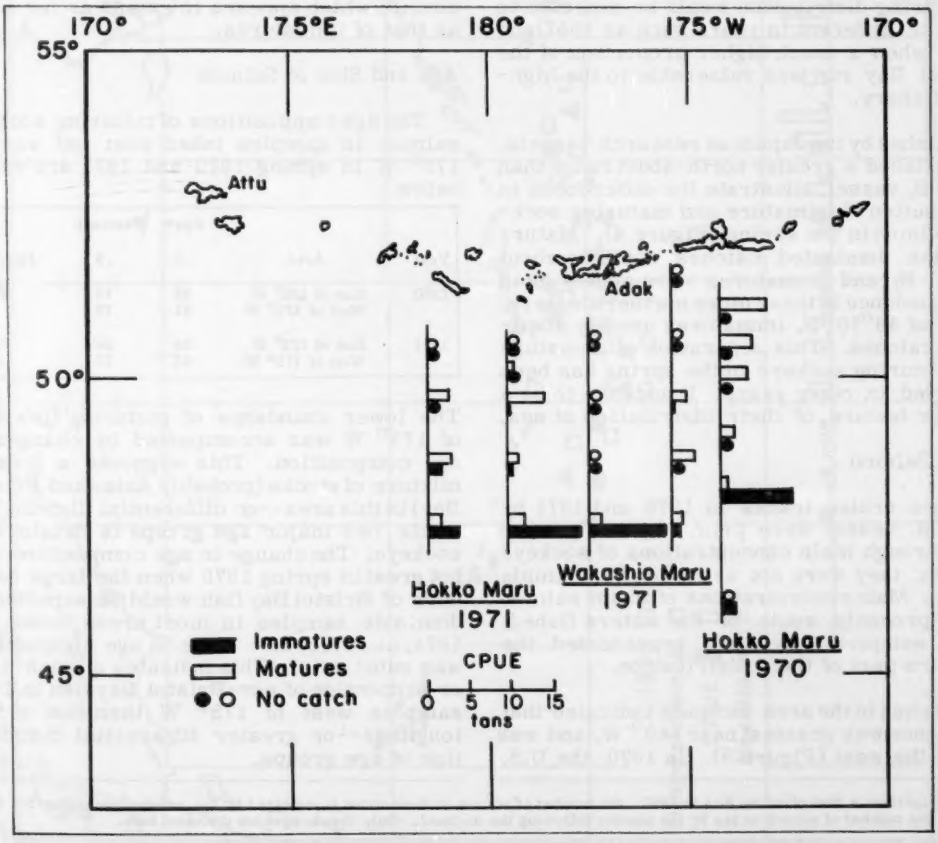


Fig. 4 - Distribution of immature and maturing sockeye salmon, spring 1970 and 1971.

The type of distribution shown in the 2 years may be typical for maturing Bristol Bay sockeye in April and May of most years. The proportion of the Bristol Bay run taken by the Japanese high-seas fishery has been estimated to range from 2% to 11% (average 7%) in 12 of 14 years from 1956 to 1969 (Fredin and Worlund, 1971). Only in 1957 and 1961 were estimates of the Japanese catch higher (35% and 24%). We anticipate that the type of distribution shown by research vessel catches in spring 1970 and 1971 would result in the usual exploitation rate of 11% or less. The majority of sockeye would be expected to use eastern Aleutian passes to reach the Bering Sea; a much smaller proportion would move west of the abstention line or already inhabit these waters and become available to the Japanese fishery. Data from Japanese commercial catches for 1970 and 1971 are not yet available to test these assumptions. The spring distribution would be expected to be quite different in years such as 1957 and 1961, when a much higher proportion of the Bristol Bay run was vulnerable to the high-seas fishery.

Catches by the Japanese research vessels, which fished a greater north-south range than the U.S. vessel, illustrate the differences in distribution of immature and maturing sockeye salmon in the spring (Figure 4). Maturing fish dominated catches south to about 48°30' N, and immatures were absent or in low abundance in these more northern waters. South of 48°30' N, immatures usually dominated catches. This separation of immature and maturing sockeye in the spring has been observed in other years. It appears to be a regular feature of their distribution at sea.

Chum Salmon

Since cruise tracks in 1970 and 1971 by the U.S. vessel were primarily designed to fish through main concentrations of sockeye salmon, they were not well suited to sample chums. Main concentrations of chum salmon were probably south of the waters fished; those sampled may have represented the northern part of their distribution.

Catches in the area sampled indicated that abundance was greatest near 160° W, and was less to the west (Figure 5). In 1970, the U.S. vessel failed to take chum salmon in many sets west of 175° W. In 1971, the Japanese vessels took chum salmon more consistently in this area but in low abundance; abundance was generally greater in 1971 than in 1970.

Fishing data furnished by the Japanese for 1970 and 1971 illustrated more accurately the location of chum salmon west of 175° W (Figure 6). Maturing chums were generally more abundant to the south--from about 47°30' N to 48°30' N. The north-south distribution of matures was extensive, extending from about 51° N to at least 41°30' N. The distribution of immatures was more restricted, extending northward to only about 48°30' N. In contrast to immature and maturing sockeye salmon, which were more clearly separated, the immature and maturing chums apparently intermingle to a much greater degree. This is due to the wide north-south range of maturing chums, which appears to extend as far south as that of immatures.

Age and Size of Salmon

The age compositions of maturing sockeye salmon in samples taken east and west of 175° W in spring 1970 and 1971 are shown below.

		Age* (Percent)		
Year	Area	.2	.3	No. of fish
1970	East of 175° W	89	11	999
	West of 175° W	81	19	52
1971	East of 175° W	34	66	590
	West of 175° W	83	17	199

The lower abundance of maturing fish west of 175° W was accompanied by changes in age composition. This suggests a greater mixture of stocks (probably Asian and Bristol Bay) in this area--or differential distribution of the two major age groups of Bristol Bay sockeye. The change in age composition was not great in spring 1970 when the large numbers of Bristol Bay fish would be expected to dominate samples in most areas fished. In 1971, however, the change in age composition was substantial. This indicates a much higher proportion of non-Bristol Bay fish in 1971 samples west of 175° W than east of this longitude--or greater differential distribution of age groups.

*Age designation is that given by Koo in 1962: the number of winters in fresh water is indicated by the number preceding the decimal; the number of winters at sea by the number following the decimal. Only ocean ages are discussed here.

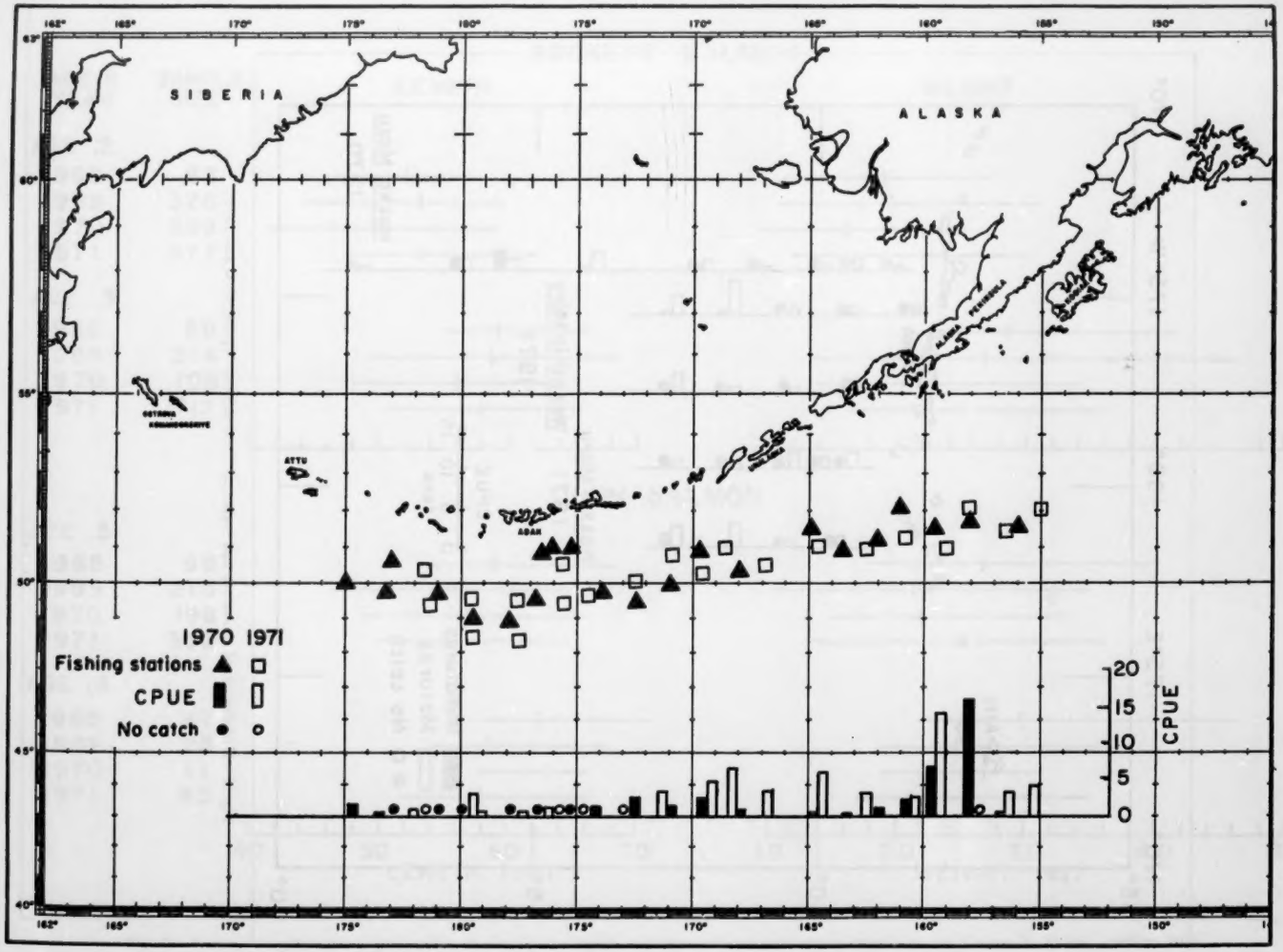


Fig. 5 - Distribution and relative abundance of maturing chum salmon--spring 1970 and 1971.

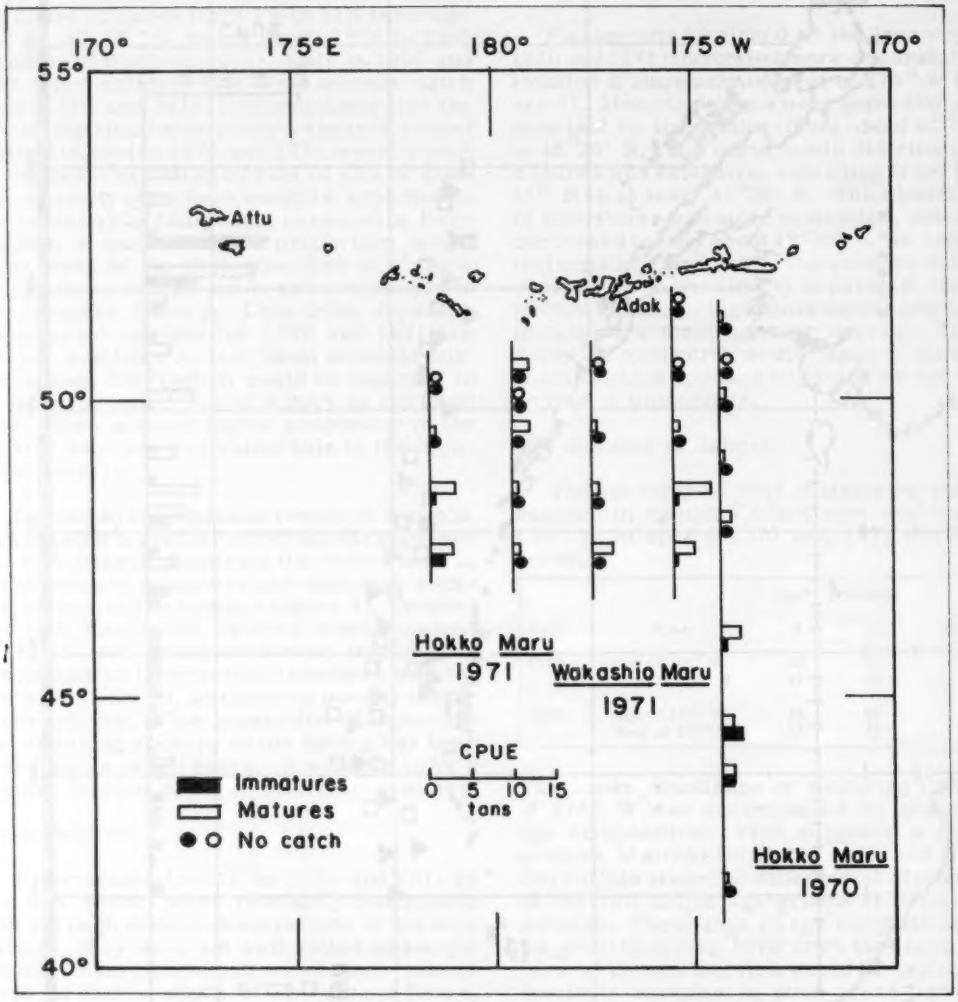


Fig. 6 - Distribution of immature and maturing chum salmon--spring 1970 and 1971.

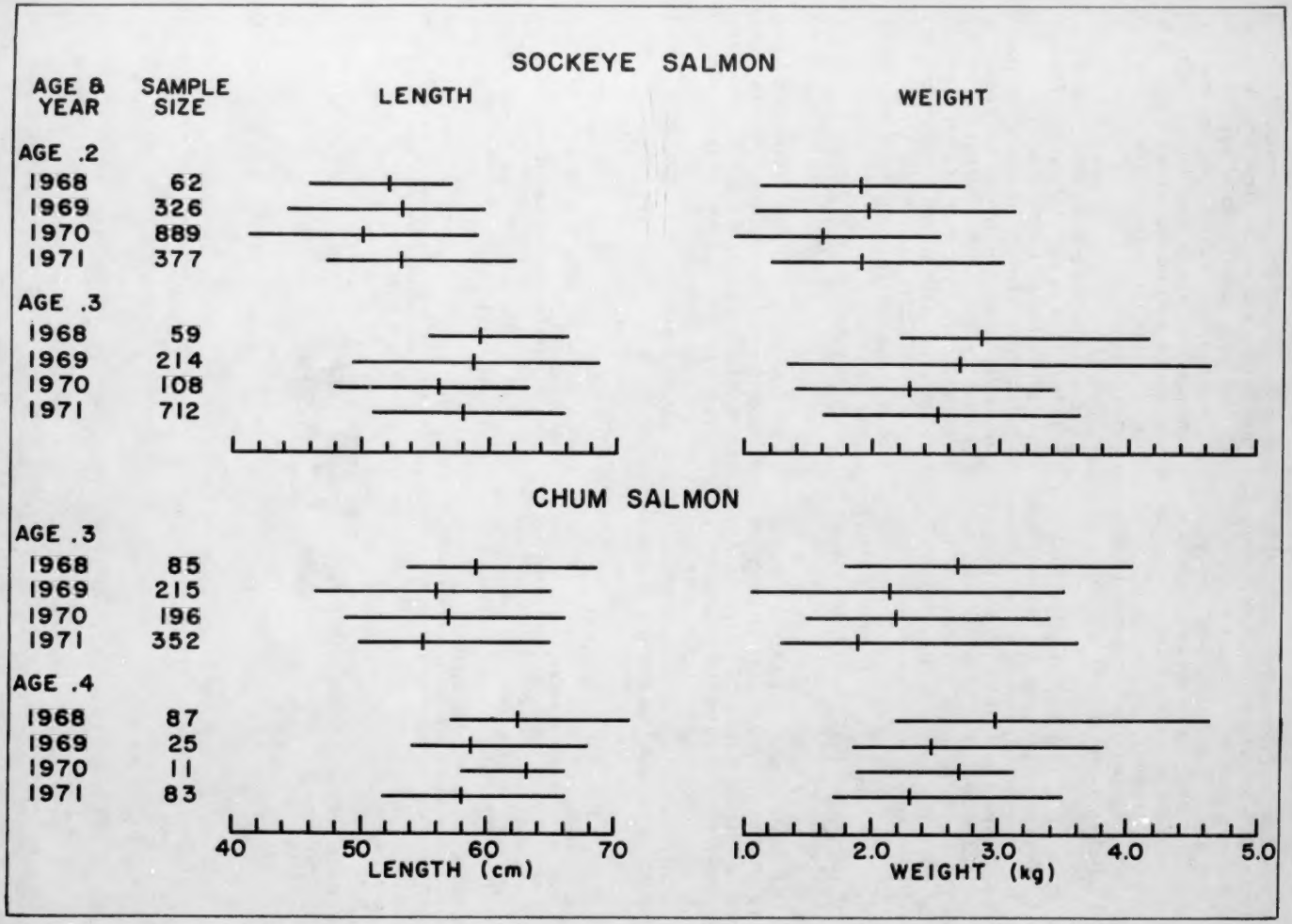


Fig. 7 - Average lengths and weights (and their ranges) of sockeye and chum salmon from spring catches of the 'George B. Kelez', 1968 to 1971.

The age composition in the 1970 Bristol Bay run was 90% age .2 and 10% age .3 sockeye. This was almost identical to the 89% age .2 fish and 11% age .3 fish taken east of 175° W. The accuracy of the predicted age composition from high seas catches was undoubtedly due to the high proportion of age .2 fish in the run and the large numbers of Bristol Bay fish at sea in spring 1970.

Based on 1971 spring sampling east of 175° W, we would forecast the Bristol Bay run to be made up of over 60% age .3 fish. This forecast assumes that the predominantly age .2 sockeye west of 175° W will not contribute substantially to the 1971 Bristol Bay run and alter the age composition shown by catches to the east.

Sockeye salmon were noticeably smaller in April and May of 1970 than in other years since 1968 (Figure 7). Average lengths of age .2 and age .3 fish were at least 2 cm (0.8 inch) smaller, and fish weighed at least 200 g (7 oz) less in 1970 than in other years. The reduced size of fish in 1970 suggests that the large numbers of Bristol Bay sockeye at sea (over 40 million fish) may have overtaxed the available quantity of food organisms. It is interesting to note that the size of age .3 fish in spring 1971 was not similarly reduced, although they shared the first 2 years at sea with the large population of age .2 fish that returned to spawn in 1970. This suggests that environmental conditions during their last year at sea may be the most critical in determining the ultimate size of maturing salmon.

Chum salmon were smaller for a given age in 1971 than in any other year. Maturing chum salmon were not particularly small in 1970, as were sockeye salmon; the size of chum salmon apparently was not greatly influenced by the large numbers of sockeye present in 1970. The type of food organisms taken by chum salmon and the distribution of chums may differ sufficiently from those of sockeye salmon to reduce the competition between species.

ACKNOWLEDGMENTS

We are grateful to the Fisheries Agency of Japan for use of catch data. Special thanks are due M. Osako, J. Ito, and T. Nishiyama, scientists on the Japanese vessels, who took extra scale samples and duplicated their data so that they would become available immediately.

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U.S. COAST GUARD'S FISHERY ENFORCEMENT POWER IS STRENGTHENED

A law signed August 11 by President Nixon gives Coast Guard Cutters on patrol in the Northwest Atlantic stronger authority to enforce international fishing agreements.

The law amends the Northwest Atlantic Fisheries Act of 1950 to keep step with recent changes in the International Convention for the Northwest Atlantic Fisheries (ICNAF). The participating nations enforce regulations designed to protect fish stocks in the Northwest Atlantic between Greenland, Canada, and the U.S.

ICNAF nations include: Canada, Denmark, West Germany France, Iceland, Italy, Japan, Norway, Poland, Portugal, Romania, Spain, USSR, United Kingdom, and the U.S. Of these, the United Kingdom, USSR, Norway, Portugal, Japan, and the U.S. have joined the inspection program.

The New Law

Under the new law, ICNAF inspectors can stop vessels of participating nations, including the U.S., board and inspect their gear and documents to check the vessel's compliance with ICNAF regulations.

Officers of the U.S. Coast Guard and NMFS will handle the inspection duties for the U.S. Before, U.S. officials had no authority to stop and board foreign vessels outside the U.S. contiguous fisheries zone.

The ICNAF agreement aims to protect several species of fish by limiting annual catches and requiring the use of nets whose mesh is large enough to permit young fish to escape. Many U.S. fishermen complain that foreign fleets use small mesh nets that capture all fish and threaten to deplete the stocks.

ICNAF Inspection

Vessels of member nations are required to stop when given the proper international signal by a ship showing an ICNAF inspection pennant. The pennant is quartered blue and yellow with "NW" in the upper yellow block.

An ICNAF inspector, after properly identifying himself, can board the vessel. He can inspect and prepare a report to be signed in the captain's presence. The captain may add comments to the report.

Reports of violations of ICNAF regulations are filed through diplomatic channels. Nets that violate the standards will be sealed, marked, and photographed.

For first offense, persons under U.S. jurisdiction who are convicted of violation of the regulations may be fined up to $1000, or be imprisoned for not more than six months, or both. For other offenses within five years, the penalty is a fine of not over $10,000, or one-year imprisonment, or both.

ICNAF Area

The ICNAF area is divided into subareas, where annual catches for each species are recorded. The agreements have three basic means for protecting fish species: limiting catches in specific subareas; closing areas completely, especially during spawning season; and prohibiting nets with mesh size below ICNAF standards.

Fish protected by ICNAF agreements include: cod, haddock, and several species of flounder.

INTERNATIONAL FISHERY STUDIES ARE UNDERWAY

The Soviet research vessel 'Blesk' and the French research vessel 'Cryos' arrived in Woods Hole, Massachusetts, in early September to begin a series of international cooperative cruises with NMFS. The Blesk will continue joint U.S.-USSR research on groundfish stocks begun in 1967; the Cryos will begin a study on distribution of sea-herring larvae.

The Blesk participated in the 1968 joint survey. This year it will conduct two operations with the U.S. research vessel 'Albatross IV': 1) Testing trawls and trawl equipment. This will include measuring gear performance on the ocean bottom and catch comparison experiments. 2) A quantitative inventory of groundfish stocks between Cape Hatteras, N.C., and Georges Bank.

Prime Objective of Research

A prime objective of the U.S.-USSR research has been to evaluate the accuracy of groundfish-abundance estimates derived from research-vessel surveys. To establish conservation regulations in international waters, it is necessary to know the impact of fishing on the stocks. Commercial fisheries statistics alone are not adequate to monitor changes in the structure and abundance of fish populations. The surveys are proving an invaluable supplement by providing abundance data of sufficient accuracy to help assess the effects of fishing on stocks.

International Agreements Important

At the present time, international agreements are the only legal means of protecting fish stocks off U.S. coast from overfishing. The NMFS Woods Hole Biological Laboratory has participated each autumn in research cruises with the USSR under a treaty negotiated when foreign fishing threatened traditional U.S. fisheries between Cape Hatteras and Long Island. This area is too far south to be regulated by the International Commission for the Northwest Atlantic Fisheries (ICNAF).

The Cryos will be one of 4 vessels in an ICNAF-organized cooperative study. The study will focus on the dispersion of herring larvae from spawning centers on Georges Bank, in the Gulf of Maine, and off Western Nova Scotia. The other vessels are the U.S. stern trawler 'Delaware II', the West German vessel 'Walther Herwig', and another Soviet vessel similar to the Blesk.

NMFS scientists from Woods Hole and Boothbay Biological Laboratory in Maine will participate.

Offshore Research Centers

The Woods Hole Lab was recently named headquarters for the new North Atlantic Fisheries Research Center, one of NOAA's four major offshore research centers. Also part of the Center are the Boothbay Laboratory and the Narragansett Sport Fisheries Marine Laboratory in Rhode Island.

Fig. 1 - The French research vessel 'Cryos' enters Little Harbor, Woods Hole, Mass., Sept. 5.

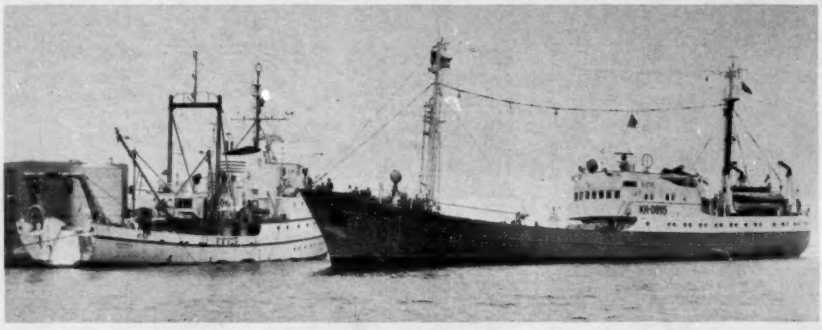


Fig. 2 - The Soviet research vessel 'Blesk' ties up alongside NMFS 'Albatross IV' in Woods Hole, Sept. 6.

Fig. 3 - Dr. Marvin D. Grosslein, NMFS, and State Dept. interpreter greet Soviet scientists.
(Photos: Robert K. Brigham)

Outside a fishmeal factory near Pisco, Peru, bags are ready to be carted away for export to North America and western Europe. (FAO: S. Lorrain)

Off the Peruvian coast, the Pacific waters support a vast amount of fish, especially anchovies. The anchovies support a large fishmeal industry. They make Peru one of the world's great fishing nations.

PERU'S ANCHOVETA FISHERY

Average Maximum Sustainable Catch Is About 9.5 Million Tons, Scientists Say

The average maximum sustainable catch of Peruvian anchoveta is about 9.5 million tons--if bird populations are of present size. In 1968-69, the catch was 9.3 million tons. The approximate limits of accuracy of this estimate are plus or minus 1 million tons.

This is the key point in a report on anchoveta prepared by a panel of scientists set up as part of the FAO/UNDP project on fisheries research and development in Peru. The panel was headed by Dr. W. E. Ricker, Biological Station, Nanaimo, B.C., Canada.

Effects of More Fishing

The scientists state that the 9.5 million tons would be taken by about the same amount of fishing as in recent seasons. If fishing effort were increased above this limit, it might increase or decrease the equilibrium yield. A way to find out whether an equilibrium yield a little larger than 9.5 million tons would be possible is to increase the annual quota experimentally. A step of not over 500,000 tons might be tried. To avoid serious trouble, the increase would be stopped or reversed at the first signs of danger--too small a catch per unit effort, scarcity of young, etc.

Closed Seasons

The scientists believe that a closed season of at least one month during December-March is very desirable. It may even be essential to maintain catch level of 9.5 million tons. The reason is that many small fish are present and are growing very fast at this time. By letting them grow during the closed season before they are caught, a greater harvest might be achieved from each generation of recruits; at the same time, a good spawning stock would be produced. Also, the percentage meal yield from large fish is greater than from small fish.

Research Needs

The panel states that "continued study and intensive monitoring of the anchoveta stock is essential to maintain control and to settle" existing problems. One important problem is the degree of mixing between stocks on different parts of the coast. The scientists recommend a pilot-scale tagging experiment to begin "as soon as possible."

CATCH AND EFFORT

The landings reported are below actual catches for these reasons: 1) losses at sea, including dumping of excess catch; 2) losses during unloading; 3) underreporting of actual quantities landed (especially during peladilla season when meal yield is low). Occasionally, these losses could reach up to 40% of reported landings.

There are uncertainties also about effort data. In all purse seining, an important factor is searching for fish.

There have been important changes in the anchoveta fleet during the development of the fishery. Vessel size has increased. Improvements in gear, equipment, and fishing have been introduced. Annual information on the effect of gear improvement for ships of the same size produced an estimate of correction for efficiency of 20% during 1960-69. The correction was introduced into the effort and catch-per-unit effort data.

IDENTITY OF STOCKS

The anchoveta and the fishery are distributed along nearly the whole Peruvian coast--and in waters off northern Chile. There are no "very clear discontinuities which would suggest isolated and separate stocks." Studies of gill rakers have revealed some differences between anchoveta stocks.

Some evidence indicates that southern anchoveta (Ilo) tend to have shorter digestive tracts than those farther north. But the overlap is great, at least in small fish. However, the scientists say, "experience elsewhere shows that differences of this sort are not inconsistent with a fairly large degree of mixing between stocks. The only way to get some idea of the degree of such mixing is to do a tagging experiment on at least a moderately large scale." The panel's study treats anchoveta as a single stock.

Fishing boats in port of Callao are drawn up and waiting for a run of anchoveta.

The ancient port, practically a Lima suburb, is bustling again. Waterfront traffic is clogged with tank trucks transferring anchovies to factories. (S. Larrain)

ASSESSMENT OF STOCK

Although guano birds have been eating fewer anchoveta, they averaged about 1.5 million tons during the study. The maximum catch by men and birds was a little over 10 million tons. A little less than 30 million gross-registered-ton (GRT) trips were involved.

In recent years, the bird populations have become smaller: eating under 1 million tons, equal to about 2 million GRT trips. A sustained catch of 9-10 million tons can be taken by fishermen with about 25 million GRT trips. More fishing might produce a larger catch, though the catch, at best, might increase only slowly. Possibly, a fishing effort greater than 25 million GRT trips could result in smaller catch.

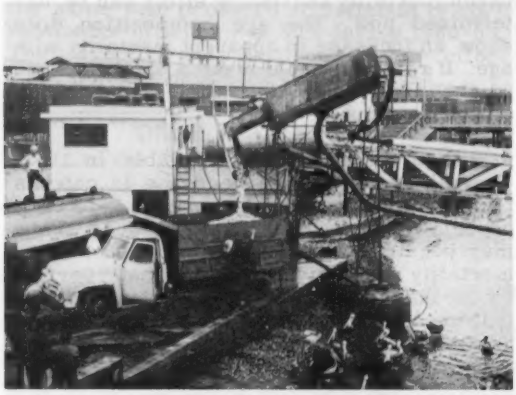
Effect of Fishing on Stocks

Age data are available only from 1962-1963 (and later). Since then, fishing effort has not varied much. No clear relation between mortality and fishing effort can be determined now. The age composition does show an increase in apparent mortality with age. If real, this could make a big difference in the analysis of the effects of different closed reasons.

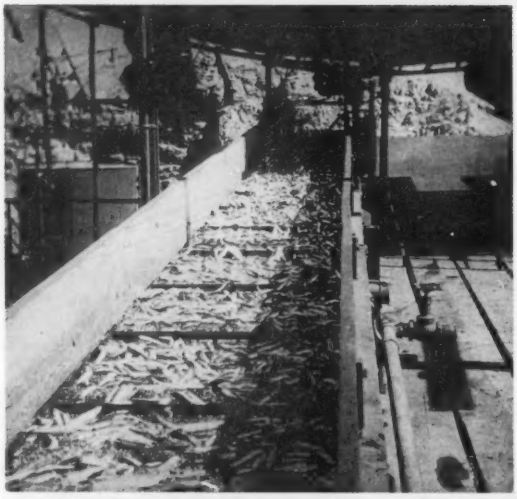
Length data became available in 1961. Overall, these show a decrease in catches per-unit-effort of the larger fish ($\geq$13 cm), especially between 1961 and 1964. This may be attributed directly to increased mortality due to fishing during that period. By 1964 (and later), fishing accounted for about half the total mortality.

Fishermen in port of Callao. (S. Larrain)

The number of very small fish (under 10 cm) has increased. The effective size at recruitment to the landings has decreased sharply. This change is due partly to fisherman behavior. In the early years, when large fish were abundant, fishermen avoided shoals of small fish; now, fishermen believe catching small fish is better than catching nothing.



Pumping anchoveta from boat to truck in Callao.



Conveyor belt transports anchoveta into fishmeal plant at Chimbote. (Photos: M. Lindner)

INDUSTRY STABLE

The record of the Peruvian anchovy fishery "is relatively free of the rather serious fluctuations in reproductive success that characterizes many pelagic fisheries; the corollary is that catastrophic collapse is not to be expected save through a very rapid increase in fishing effort, which seems unlikely."

In the cases of the California sardine and the Georges Bank haddock, "catastrophic declines appear to have occurred as a result of fishery induced recruitment failures." The immediate cause was intense fishing and a series of poor year-classes from environmental (stock-independent) reasons. The combination of factors reduced stock to such a low point that the possibility of good year-class, even under favorable environmental conditions, was small.

BIRDS

The scientists say that fisheries of 1 to 2 million tons have no "appreciable effect" on the birds. Fisheries of 4 to 7 million tons reduce the anchovy population to a level that restricts birds to about 16 million. The present fishing level holds bird population to 5-6 million.

ECONOMICS

The panel doubts the desirability, for economic reasons, of fishing hard enough to achieve maximum catch. It would be desirable to fish appreciably less than that and catch only slightly fewer fish.

JAPAN

NEW U.S. POLICY HURTS JAPANESE FISHERY EXPORTS

The economic policy announced by President Nixon on August 15, 1971, has hurt Japanese fishery exports. The 10% surcharge on U.S. imports was expected to affect immediately Japanese trading firms with unsold supplies and also processors. The problem of international currency revaluation, too, faces the industry.

In 1970, fishery exports totaled US$390 million, based on Japanese customs-clearance records. Of that, $116 million (30%) were sales to the U.S.: principally canned tuna, canned crab, canned oysters, frozen tuna, and pearls. Canned mackerel and whale oil were about 10% of sales.

The 10% surcharge is not expected to apply to frozen tuna exports, which are exempt from U.S. import duty. However, other fishery products will be affected. Therefore, no new sales are likely for a while. Even those already contracted, but not yet cleared through U.S. customs, face problem of additional charge.

Canned-Tuna Exports

Canned-tuna exports to the U.S. will be assessed the 10% surcharge above the present 7% ad valorem import duty. In 1970, the U.S. took about $43 million, 54%, of the $80 million worth of Japan's canned-tuna exports. In second half of August 1971, there were about 800,000 cases of canned tuna in brine sold to U.S. buyers but not yet cleared through U.S. customs. These were subject to surcharge. Normally, the importers pay additional charge if sales contract already has been concluded. In all probability, the importers will not be able to bear this burden, so contract cancellations are likely.

Canned-Tuna Industry's Problems

The Japanese canned-tuna industry feels it has received a triple blow: 1) by U.S. Food and Drug Administration's seizures of shipments because of excess mercury; 2) by that agency's detentions of shipments because of decomposed tuna; and 3) the surcharge. From January to late July 1971, FDA's detentions were 110,000 cases (about 75,000 cases for decomposition, 35,000 cases for mercury). Losses are estimated to reach 770 million yen ($2.14 million), based on 7,000 yen ($19.44) per case (including two-way ocean freight costs). Some packers face grave financial difficulties.

Ed. Note: On Sept. 1, the U.S. Treasury exempted from surcharge: imports at sea on Aug. 15; items in bonded warehouses; foreign-trade zones and tied up by West Coast dock strike.

Canned Pink Salmon

Canned pink salmon exports to the U.S. also have been reduced. Negotiations for sales of 300-500,000 cases, which had been in progress prior to President Nixon's announcement, stopped. It produced a tremendous inventory buildup in Japan. Also, an upward revaluation of the yen will produce a financial loss to trading firms that have purchased canned salmon from the Sales Company for export to Europe and Australia. At least half the one million cases have not yet been exported to those countries. ('Suisan Tsushin', Aug. 5 & 19.)

* * *

EXPORTS RECORDED SHARP GAINS IN 1970

The Fisheries Agency reports that Japanese fishery exports during Jan.-Dec. 1970 totaled US$390.8 million on a customs-clearance basis. This is over 12% above 1969's $346.8 million. The ratio of fishery exports to total value of export trade, however, fell to post-World War II low of 2% in 1970 from high of 7.7% in 1958. Exports to the U.S. in 1970 were 32% of total shipments, the same as in 1969.

Fishery Exports 1968-70

	Value		
	1970	1969	1968
		(US$1,000)	
Frozen and fresh	98,766	86,001	90,703
Canned and bottled	203,204	175,870	181,795
Salted and dried	11,799	12,094	8,922
Oils and fats	10,845	5,069	3,807
Agar-agar	3,324	4,408	4,817
Pearl	40,902	48,640	46,802
Other fishery products	21,900	14,810	13,753
Total	390,820	346,892	350,602

JAPAN (Contd.):

Principal Importers

Country of Destination	1970	Value 1969	1968
		(US$1,000)	
U.S.	116,532	103,862	103,239
Great Britain	46,765	37,009	59,368
West Germany	25,227	22,819	21,043
Italy	16,254	12,367	14,957
Philippines	16,111	15,978	19,745
Netherlands	13,840	8,736	7,230
Hong Kong	11,452	11,244	7,923
Ryukyu Islands (Okinawa)	11,186	10,363	7,893
Canada	10,921	7,558	5,977
Switzerland	10,377	12,000	10,823
Australia	9,783	11,137	9,281
Puerto Rico	8,655	6,462	8,858
Ghana	7,099	2,531	1,915
Belgium	5,750	7,088	4,990
France	5,593	9,500	8,323

Principal exports in 1970 were: canned tuna--$80,170,000 (U.S. 53.6%); canned mackerel--$44,350,000; pearls--$40,900,000; canned salmon--$44,950,000; frozen tuna--$31,760,000 (U.S. 71.5%). ('Suisan Tsushin', July 17; 'Minato Shimbun', July 18.)

* * *

FISHERY IMPORTS INCREASE

In 1970, Japanese imports of frozen fishery products reached 374,569 metric tons worth US$318,412,000. This is an increase of 34% in quantity and 200% in value compared with 1965 imports of 278,940 tons worth $103,950,000.

Shrimp, the leading import, was 43% of imports in value, followed by tuna (8%). Other important products included squid, fishmeal, salmon roe, and octopus. Together with shrimp and tuna, these were about 69% of total value of fishery imports.

Fishery Imports, 1965-70

	Quantity	Value (at customs clearance)
	Metric Ton	US$1,000
1965	278,940	103,950
1966	333,799	167,550
1967	330,950	191,573
1968	370,143	200,374
1969	362,628	260,676
1970	374,569	318,412

Frozen Shrimp Imports, 1965-70

	Quantity	Value (at customs clearance)
	Metric Ton	US$1,000
1965	21,011	35,938
1966	36,156	60,085
1967	44,466	79,732
1968	35,204	78,079
1969	48,886	121,747
1970	57,146	137,026

Leading suppliers (in value) were: South Korea, 12.4%; Communist China, 9.9%; U.S., 7.6%; Taiwan, 7.5%; and Mexico, 6.4%. ('Suisan Keizai Shimbun', July 22.)

* * *

BRISTOL BAY CRAB FACTORYSHIPS DOING POORLY

The 'Koyo Maru' and 'Keiko Maru' crab factoryship fleets fishing in the Bristol Bay were doing poorly because of unseasonally cold waters. During the first months after late March, they were troubled by heavy ice floes.

The production quotas assigned to the two fleets for the 1971 Bristol Bay crab fishery are: 'Koyo Maru' fleet--king crab 18,300 cases and 7.14 million tanner crabs; 'Keiko Maru' fleet--king crab 19,200 cases and 7.46 million tanner crabs.

As of Aug. 10, production by the two fleets was: 'Koyo Maru' fleet--frozen king crab meat 181,534 metric tons, frozen tanner crab 3,513.3 tons; 'Keiko Maru' fleet--canned king crab 5,314 cases; frozen king crab equivalent to 6,824.5 cases, and frozen tanner crab 3,478 tons. (Suisan Keizai Shimbun', Aug. 17.)

* * *

LONGLINER RETURNS FROM U.S. EAST COAST WITH GOOD BIGEYE CATCH

The tuna longliner 'Juju Maru' (299 gross tons) recently returned to Japan with 248 metric tons of bigeye, mixed with some yellowfin, taken in northwestern Atlantic off New York. The value was 157 million yen (US$436,100).

JAPAN (Contd.)

The vessel left Japan early this year. It spent 184 days at sea, fished 73 times, and caught an average of 3.5 tons of fish per set. Fishing was very good compared with vessel's experience in fishing for southern bluefin in the South Pacific. There it took 130 sets, or almost twice as many sets, to fill the holds.

The outlook for bigeye fishing off the U.S. east coast is promising. So more Japanese longliners are likely to begin fishing if planned voluntary regulation of southern bluefin fishery is put into effect. The regulation involves specified areas of South Pacific and Indian oceans. ('Katsuo-maguro Tsushin', Aug. 6.)

* * *

RESEARCH VESSEL TO SURVEY TUNA GROUNDS IN NORTH ATLANTIC

The 'Azuma Maru No. 28' (313 gross tons), chartered by Marine Fishery Resources Development Center, left Japan July 29 on a survey cruise to North Atlantic. The vessel is scheduled to survey the region between 30° N.-60° N. latitudes. Previous private explorations, with government subsidy, showed promise for bigeye, bluefin, and albacore fishing.

Tuna's Northern Limits

Main effort of the cruise will be to test prospects for commercial exploitation in northern limits of Atlantic's traditional tuna fishing grounds. The survey, September 9 until February 1972, covers a northward course along Gulf Stream. This will take vessel near the British Isles. ('Suisan Keizai Shimbun', July 29.)

* * *

TEST SKIPJACK FISHING OFF PONAPE, U.S. TRUST TERRITORY

The Overseas Fishery Company is conducting a study to determine the feasibility of starting a skipjack tuna fishery off Ponape, U.S. Trust Territory of the Pacific Islands. The firm is fishing experimentally for skipjack off New Guinea with 8 vessels out of Rabaul. It hopes to establish another base at Ponape because of good fishing in New Guinean waters.

However, the proposed venture faces difficulties because the government of Ponape has strict licensing rules. Basically, these do not permit foreign investment unless it helps local inhabitants.

1 Japanese Firm There

In Ponape, there already is one Japanese trading firm, Mitsui Bussan, and the Okinawan fishery firm Sanyo Gyogyo. In partnership with Ponape interests, these are getting ready to fish for skipjack with one mothership and three vessels. ('Katsuo-maguro Tsushin', July 28.)

* * *

PLAN TO FISH SKIPJACK IN INDONESIAN WATERS

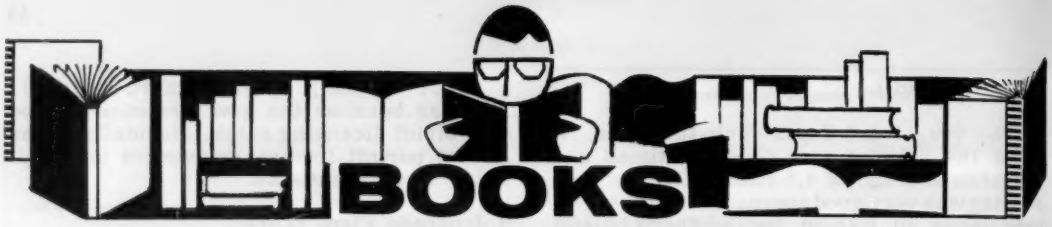
Hoko Suisan, in partnership with Toyomenka, is proceeding with plans to establish a skipjack tuna fishing base at Butung Island, Indonesia, in the Banda Sea. In mid-August 1971, the firm's mothership plus three skipjack vessels were scheduled to depart Japan. They will fish in about the same area now being worked by Nichiro and Mitsubishi Shoji. In May 1971, Nichiro obtained a fishing license from Indonesia. ('Katsuo-maguro Tsushin', Aug. 12.)

* * *

INDIAN FISHERY TRADE MISSION VISITS JAPAN

An 8-man Indian fishery trade mission recently visited Japan to study the market and to confer with trading firms about importing fishery products from India. The group hopes the Japanese will buy more small-size shrimp from India. Only Mexico supplies Japan with more shrimp. In 1970, India's shrimp exports to Japan were 6,400 metric tons (mostly large size).

The visitors also sought Japanese participation in joint ventures to promote India's fishing industry. ('Suisan Keizai Shimbun', Aug. 18.)



The following publications of the Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, are available free from Division of Publications, NOAA, Connecticut Ave. & Van Ness St. NW., Bldg. 52, Washington, D.C. 20234:

FISH-AGE DETERMINATION

"Age Determination of Fishes (Revised)," by Fred E. Lux, Fishery Leaflet 637, illus., 7 pp., June 1971.

How long fishes live and how large they grow vary widely. A European goby lives its life within a single year; it is slightly over one inch long when mature. Other fishes live beyond 100 years.

Age and growth-rate data are vital to fishery management. The growth rate of commercial fish must be known to learn the age and size for harvesting them most efficiently. Age information also helps to judge the results of management practices.

"Three basic methods have been used for age and growth determination of fishes: 1) observation of the growth of fishes of known age, 2) study of fish size-frequencies, and 3) study of seasonal ring formation in hard body parts such as scales and bones. The method used usually depends upon special problems encountered in age determination of a given species."

BLUE CRAB MEAT

"Blue Crab Meat - I. Preservation by Freezing," by Jurgen H. Strasser, Jean S. Lennon, and Frederick J. King, SSR-Fish. No. 630, illus., 26 pp., July 1971.

The blue crab (Callinectes sapidus) is one of the most valuable U.S. commercial shellfishes--"in volume of landings and in value of its food products." The industry has one of the greatest seasonal variations in exvessel prices of any shellfish. Several factors are involved: short life span of crab (2-3 years) and need to keep it alive until cooked to remove the meat. A more significant factor is that meat itself is highly perishable. Virtually all of the present output is sold as fresh meat, "which has a shelf life of up to 10 days at 32° to 38° F."

The authors studied freezing as a method of preserving blue-crab meat for up to 8 months. "The results indicate that a rapid freezing rate, storage below 0° F, and vacuum packaging are preferable to minimize losses in the desirable qualities of freshly picked meat."

CALICO SCALLOPS

"Calico Scallops of the Southeastern United States, 1959-69," by Robert Cummins Jr, SSR-Fish. No. 627, 22 pp., illus., June 1971.

The author summarizes developments in the calico scallop resource of southeastern United States. He provides a background and description of the fishery in North Carolina and its expansion later to Florida grounds. Also, there are sections on quality of the scallop and its parasites, development of processing machinery, recent industry activity, and NMFS technical assistance.

SALMON

"Alaska's Fishery Resources - The Chum Salmon," by Theodore R. Merrell Jr., Fishery Leaflet 623, 7 pp., illus., June 1970.

Although less highly regarded than the others, "the chum salmon, Oncorhynchus keta, is the most widely distributed and second most abundant of the five Pacific salmon. It is one of Alaska's valuable fishery resources."

The chum spawns in late summer and fall. Some spawn in small streams near the ocean;

others travel as far as 1,500 miles from the ocean to spawn in large rivers. The young hatch in midwinter but stay in the stream gravel until spring. Then they emerge and migrate to sea, where they spend 2 to 4 years. They weigh about 10 pounds when they return to spawn and die in their native stream.

Most chum are caught in purse seines and canned; hundreds of thousands are caught in gill nets and fish wheels for human and dog food. The chum fishery is mostly in large rivers running into Bering and Chukchi Seas of northern Alaska. Little biological research has been done on chum salmon, so less is known about them than the other Pacific salmon.

The leaflet also contains information on geographic distribution, life history, economic importance, and selected references.

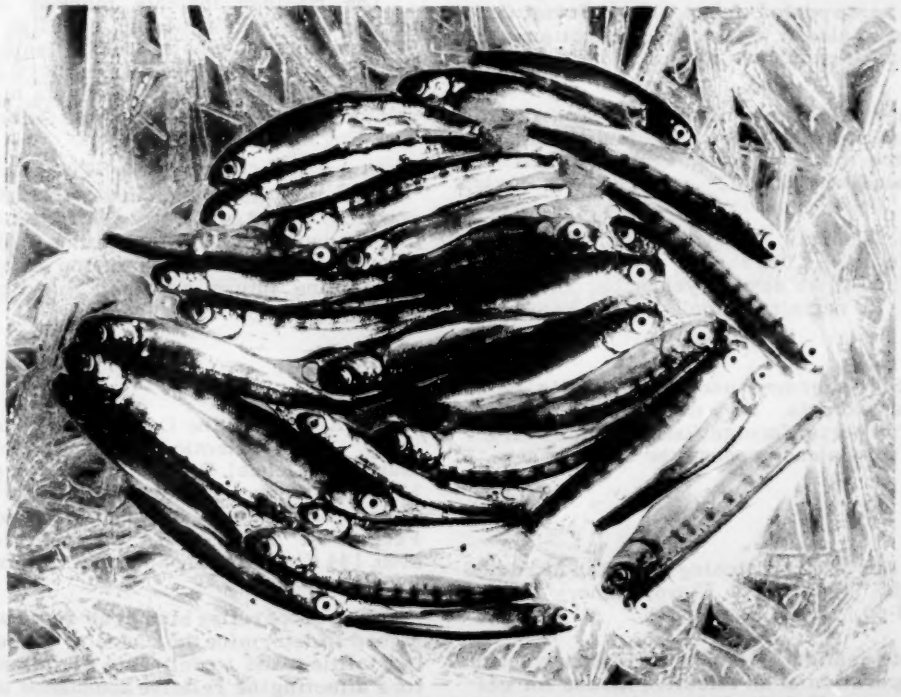
"Alaska's Fishery Resources - The Pink Salmon," by Jack E. Bailey, Fishery Leaflet 619, 8 pp., illus., March 1969.

"Pink salmon, Oncorhynchus gorbuscha, are called the 'bread and butter fish' of the Alaskan salmon industry because they are the most consistently abundant of the five Pacific salmons in Alaska--pink, sockeye, chinook, coho, and chum.

"The name 'pink' comes from the delicate color of the flesh of the pink salmon, which is also known as 'humpy' or 'humpback' salmon because of the hump that develops on the back of the spawning male."

This leaflet describes the fish; gives its geographic distribution and abundance; natural history (spawning, survival, food and growth, and migrations); economic importance; research and management; and publications.

"Alaska's Fishery Resources - The Sockeye Salmon," by Wilbur L. Hartman, Fishery Leaflet 636, 8 pp., illus., March 1971.



Pink and chum salmon fry that have just emerged from the streambed. The pink salmon are distinguished by their smaller size and the lack of the parr marks that are noticeable on the backs of the chum salmon fry. In the live fish the fins are nearly transparent because they are very thin and unpigmented.

Sockeye salmon, Oncorhynchus nerka, known too as red salmon, come from the river-lake systems in Alaska, Canada, and the Soviet Union. The female carries about 3,500 eggs and spawns in late fall in the inlets and outlets of lakes and in the lakes themselves. The sockeye is a renewable resource economically important to Alaska. "Its deep red flesh, rich in oils, makes the sockeye salmon the most highly prized of the five Pacific salmons for canning or smoking."

The leaflet includes the sockeye's life history, management of fishery, scientific research, and references.

SHRIMP

"Alaska's Fishery Resources - The Shrimps," by Louis Barr, Fishery Leaflet 631, 10pp., illus., January 1970.

Shrimp fishing in Alaska began more than 50 years ago. In recent years the annual domestic catch has reached 40 million pounds; in the same period, Japanese and Soviet fishermen in Alaska waters have caught as much as 70 million pounds a year.

The five commercially important Alaskan shrimp are members of the family Pandalidae; the most important is the pink shrimp, Pandalus borealis.

These shrimp all have similar complicated life histories. The shrimp develops first as a male and, after several years, becomes a female. It remains female for the rest of its life.

U.S. fishermen use otter trawls, beam trawls, and pots. They deliver their catch to Alaskan ports; foreign fishermen use larger otter trawls and process the catch at sea.

LIFT NET

"A Lift Net for Catching Bait Fish Attracted to Light," by Hilton M. Floyd, Fishery Leaflet 638, 3 pp., illus., April 1971.

This leaflet "describes the construction and operation of an effective means for collecting small bait fish such as anchovies, sardines, chub mackerel, thread herring, and cigarfish. The gear is small and portable and can be easily handled by one man from a boat, dock, or bridge. Because the net is light, its use is limited to areas of little or no current."

SHELLFISH CONSUMPTION

"Regional and Other Related Aspects of Shellfish Consumption--Some Preliminary Findings From the 1969 Consumer Panel Survey," by Morton M. Miller and Darrel A. Nash, Circular 361, 18 pp., illus., appendix, and errata, June 1971.

A consumer panel of representative U.S. households recorded their purchases of fishery products for 12 months beginning February 1969. They were taking part in a study conducted under sponsorship of the NMFS Division of Economic Research. This leaflet deals mainly with findings on consumption of major shellfish species at home and away from home.

The findings indicate marked regional preferences for individual shellfish items. For example, people in South Atlantic States eat oysters at nearly double the U.S. per-capita rate. Similarly, there is a high consumption rate of clams in Middle Atlantic and New England areas.

"The results of the survey can be developed into useful guidelines for industry decisions, especially in marketing. Also the results can greatly enhance the accuracy of forecasting future economic events in the fishing industry."

BLUE CRAB

"A Report on the Cooperative Blue Crab Study - South Atlantic States," by Robert K. Mahood, Michael D. McKenzie, Douglas P. Middaugh, Sean J. Bollar, John R. Davis, and Dennis Spitsbergen, 32 pp., illus., appendix, Feb. 1970. Chief, NOAA, Federal Aid Division, 144 First Avenue South, St. Petersburg, Florida 33701.

"The cooperative blue crab study was designed to determine the cause(s) of blue crab mortalities and to delineate significant factors affecting the relative abundance of marketable crabs. A multiphased approach provided background information relative to

regional hydrological characteristics, diseases and parasites, and residual pesticides associated with blue crab populations."

Twenty South Atlantic sampling areas were monitored routinely. It produced hydrological data that illustrated typical seasonal patterns.

The researchers collected 195 blue crab samples (1,950 individual crabs) and analyzed these for pesticides.

SOUTH CAROLINA

"An Investigation of the Offshore Demersal Fish Resources of South Carolina," by Charles M. Bearden and Michael D. McKenzie, Technical Report No. 2, 19 pp., illus., May 1971. South Carolina Wildlife Resources Department, Marine Resources Division, Charleston, South Carolina.

The live bottom and continental shelf-edge habitats of South Carolina support many bottom fish. In recent years, commercial fishermen and related fishery interests have recognized the potential economic value of these resources. Federal, State, and local agencies have conducted exploratory fishery surveys.

In March 1970, South Carolina entered into agreement with NMFS to study State's offshore demersal fish resources.

Objectives: 1) "To accumulate and evaluate existing data on the species composition, distribution and availability of commercially valuable demersal fishes found on the Continental Shelf, especially sea basses, snappers, groupers, porgies, and grunts.

2) "To compile additional data on the commercial potentials of offshore fishery resources through exploratory fishing in selected areas using fish traps and handlines.

3) "To supplement existing biological knowledge of the offshore demersal fish populations."

OIL POLLUTION

"Oil Pollution on Wake Island from the Tanker 'R.C. Stoner'," by Reginald M. Gooding, SSR-Fish. No. 636, 12 pp., illus., May 1971, 25 cents. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

In 1967, the tanker R.C. Stoner foundered on a reef about 200 miles southwest of harbor entrance at Wake Island. It was carrying over 6 million gallons of petroleum products.

A shore and underwater survey of the contaminated coastline found that an estimated 2,500 kg. of inshore reef fishes were killed and stranded on shore. "Numerous other fish and invertebrates were probably killed. Evidence is cited which indicates that most of the kill occurred on the shallow reef flat." The author speculates on the lethal effect of the various fuels.

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BACK COVER: The catch was dogfish.
(R. K. Brigham)